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SOLVING THE UNITED KINGDOM'S PRODUCTIVITY PUZZLE IN A DIGITAL AGE

DISCUSSION PAPER
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Jacques Bughin | Brussels
Jonathan Dimson | London
Vivian Hunt | London
Tera Allas | London
Mekala Krishnan | Boston
Jan Mischke | Zurich
Louis Chambers | London
Marc Canal | Madrid

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ACKNOWLEDGMENTS

This paper is our attempt to shed light on the productivity puzzle for the United Kingdom. We have tried to provide a useful understanding of why productivity growth has slowed sharply in the United Kingdom in recent years. In addition, we have tried to create a framework for how to accelerate productivity growth in the country in the future.

This paper was a joint project between McKinsey & Company's UK and Ireland office and MGI. The research was led by Tera Allas, senior fellow at the McKinsey Center for Government, and Jonathan Dimson and Vivian Hunt, both senior partners of McKinsey & Company, together with Jacques Bughin, a director of MGI and senior partner of McKinsey & Company, Jan Mischke, an MGI partner, and Mekala Krishnan, a senior fellow at MGI. The project team was led by Louis Chambers and Marc Canal and included Samuel Cudre, Kimberley Moran, and Naba Salman. This paper was edited and produced by senior editor Anna Bernasek, editorial production manager Julie Philpot, digital editor Lauren Meling, senior graphic designer Marisa Carder, and graphic design specialist Margo Shimasaki. John Cheetham, Ian Gleeson, and Nicola Montenegri together with Nienke Beuwer managed dissemination and publicity.

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We are grateful for all the input we have received, but the final paper is ours, and all errors are our own. We welcome your comments on this research at **MGI@mckinsey.com**.

IN BRIEF

SOLVING THE UNITED KINGDOM'S PRODUCTIVITY PUZZLE IN A DIGITAL AGE

The United Kingdom went into the financial crisis with one of the lowest labour productivity levels among European peers and emerged with the steepest decline in productivity growth. While productivity growth has recovered slightly since 2014, it remains near historic lows. Developing headwinds, such as demographic shifts and uncertainty surrounding Brexit, mean that improving productivity will be more important than ever for raising living standards. We identify key reasons for the United Kingdom's recent weak productivity performance by analysing cross-country, regional, and sectoral patterns as well as other decompositions of aggregate statistics, and outline steps policy makers and firms can take to promote growth.

- The United Kingdom's labour productivity growth slowdown was broader-based than France, Germany, and Spain, occurring across all regions and 83 percent of sectors. Despite this, the financial and manufacturing sectors played outsize roles, as did a drop in total factor productivity (TFP) growth. We identify four main reasons for these patterns.
- The financial sector experienced a boom ahead of the crisis and a bust in the aftermath, accounting for about 20 percent of the productivity growth slowdown in the United Kingdom and a third of the decline in TFP growth. While the United States also experienced a boom/bust cycle in finance, the impact was much smaller, only about 10 percent. Growth in loans and deposits contracted sharply in the United Kingdom after the financial crisis while the fixed nature of many inputs meant that hours worked barely changed.
- The United Kingdom stands out as having the strongest growth in hours worked in our European sample after the crisis, three times the average rate of our sample. The increase in hours reflected not merely a rebound from the crisis but additional hiring, with two million more people, especially the young and old, employed between 2010 and 2015. Policy changes to apprenticeships, university fees, and pensions may have influenced labour supply dynamics. Low wage growth reinforced hiring ahead of capital investment, especially given the heightened economic uncertainty.
- UK investment was the lowest in our sample of advanced economies going into the crisis and fell further in the aftermath. The decline was mainly from a reduction in equipment and structures investment, while investment in intangibles such as software and R&D increased slightly. Weak equipment investment has implications for achieving labour savings and played a role in the productivity growth decline in manufacturing.
- While the United Kingdom ranks highly in broad measures of digital adoption, there are gaps. The country does well in internet access, basic digital skills, and the adoption of cloud computing but poorly in the integration of information systems across the value chain, business process transformations, enterprise digitisation, and robotics. We find opportunities to boost productivity growth from digitisation but they come with adoption barriers, lags, and transition costs, and the benefits have not yet occurred at scale.
- Across countries we analysed, there is potential for at least 2 percent productivity growth a year over the next ten years. However, capturing that potential in the United Kingdom will take time and is not guaranteed. It will require policy makers and businesses to take decisive action in key areas: skill building for the existing and future workforce and managers; accelerating adoption of digital through better information, access to finance, collaborations, and a favourable policy environment; and promoting additional investment and exports.

WHAT HAPPENED TO UK PRODUCTIVITY GROWTH?

Productivity growth in the UK averaged **2%** before the financial crisis (2000–05), but only **0.2%** after (2010–15)

The financial and manufacturing sectors accounted for nearly **50%** of the aggregate slowdown

Hours worked growth was **3x** that of comparable countries in 2010–15, pointing to an employment puzzle, with **2M** more people employed

Equipment investment as a share of value added declined by **20%** post- vs pre-crisis, of which **50%** came from manufacturing

~20% of UK companies cited various forms of uncertainty as a main reason for not investing

UK manufacturing robotics adoption lags at **23%** of Germany's rate

Yet advanced economies, including the UK, could boost annual productivity growth to **2%+** with supportive action

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INTRODUCTION

Declining labour productivity growth characterized many advanced economies after a boom in the 1960s, but since the mid-2000s that decline has accelerated. Against that backdrop, the United Kingdom stands out as one of the worst productivity performers among its peers. Its absolute level of productivity has persistently ranked towards the bottom of a sample of advanced economies. Moreover, in the aftermath of the crisis, the United Kingdom, along with the United States, recorded one of the lowest productivity growth rates and steepest declines in productivity growth compared to those same countries, falling by 90 percent.[1] Between 2010 and 2015, UK productivity growth flatlined at 0.2 percent a year, far below its long-term average of 2.4 percent from 1970 to 2007. Productivity growth is important for all advanced economies as they navigate potential economic headwinds, such as an aging population and an ongoing shift to low-productivity services like healthcare and education, but particularly for the United Kingdom with an uncertain outlook for trade and investment after Brexit.[2]

Several explanations have been offered for the United Kingdom's poor productivity performance. These include low capital investment after the financial crisis and Brexit referendum, poor reallocation of capital to the most productive businesses, a productivity growth slowdown in key sectors such as finance and telecommunications after a pre-crisis boom, a slowdown in the rate of innovation and diffusion, and mismeasurement of output growth (see Box 1, "The role of mismeasurement in the UK productivity growth slowdown").[3] In this paper, we bring together a comprehensive evidence base, drawing from international comparisons and country-specific analyses, to highlight the distinct features of the United Kingdom's productivity growth slowdown. The resulting insights provide a fresh perspective on a stubborn question and shed light on what can be done to restart UK productivity growth.

Our analysis builds on recent productivity research at the McKinsey Global Institute (MGI), McKinsey & Company's UK and Ireland office, and the McKinsey Center for Government. In 2017, MGI launched a research effort investigating the productivity growth slowdown since the mid-2000s across major European countries including the United Kingdom, and the United States. That research culminated in the publication of *Solving the productivity puzzle: The role of demand and the promise of digitization*.[4] In addition, recent research by

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1 Our sample of five advanced economies includes France, Germany, Spain, the United Kingdom, and the United States. Note that this discussion paper focuses on explanations for and policy implications of the productivity growth slowdown between 2000–05 and 2010–15 using primarily sector-level evidence. We therefore do not elaborate on the underlying reasons for the United Kingdom's low absolute level of productivity and draw attention to these only where they are also relevant to the recent productivity growth slowdown. As a result, the paper does not cover in detail, for example, issues of demand, inequality, workforce diversity, infrastructure, supply chains, skills mismatches, management practices, regional productivity differences, innovation diffusion, or firm-level evidence (e.g., the role of small and medium-size enterprises). Of course, some of the reasons for low productivity levels do point to potential actions for boosting future productivity growth, and we capture the most important of these in the recommendations section of the paper.

2 The measurement of labour productivity in health and education is problematic and is unlikely to capture the full value of these services; however, as measured in national accounts, their relative level of productivity is low.

3 See, for example, *UK productivity trends: How are they influenced by financial services?* TheCityUK Independent Economist Group, May 2013; Peter Goodridge, Jonathan Haskel, and Gavin Wallis, "Accounting for the UK productivity puzzle: A decomposition and predictions", *Economica,* December 2016; João Paulo Pessoa and John Van Reenen, "The UK productivity and jobs puzzle: Does the answer lie in wage flexibility?" *Economic Journal,* May 2014, Volume 124, Issue 576, pp. 433–52; Alina Barnett, Adrian Chiu, Jeremy Franklin, and Maria Sebastia-Barriel, *The productivity puzzle: A firm-level investigation into employment behaviour and resource allocation over the crisis,* Bank of England working paper number 495, April 2014; "Productivity puzzles", speech by Andy Haldane, Bank of England, at London School of Economics, March 2017; Diane Coyle, *Do it yourself digital: The production boundary and the productivity puzzle,* Economic Statistics Centre of Excellence discussion paper number 2017-01, June 2017; Diane Coyle, "Commentary: Modernising economic statistics: Why it matters", *National Institute Economic Review,* November 2015, Volume 234, Issue 1.

4 *Solving the productivity puzzle: The role of demand and the promise of digitization,* McKinsey Global Institute, February 2018.

McKinsey's UK and Ireland office has highlighted the importance of management skills, innovation diffusion, and regional variations to understanding the productivity puzzle, while the McKinsey Center for Government has identified vast opportunities from unlocking productivity growth in the public sector.[5]

This paper extends the analysis and findings of MGI's *Solving the productivity puzzle* to provide a deeper understanding of the United Kingdom's most recent period of reduced productivity growth following the financial crisis. The MGI report found that the waning of a productivity boom—fuelled by information and communications technology (ICT), outsourcing and restructuring that began in the 1990s—and financial crisis aftereffects, including weak demand and uncertainty, dragged down productivity growth by 1.9 percentage points on average, from 2.4 percent to 0.5 percent, across the United States and Western Europe for the period 2010 to 2014 compared to the period 2000 to 2004.[6] It also found that digitisation was occurring across these countries with significant potential to reignite productivity growth, but the benefits had not yet materialised at scale. The slow impact of digitisation on productivity growth is due to adoption barriers and lag effects as well as transition costs. The report concluded that as financial crisis aftereffects continue to recede and more companies incorporate digital solutions, productivity growth has the potential to recover across countries. It calculated that the productivity growth potential from both digital and nondigital opportunities could be at least 2 percent per year over the next decade. However, realising this opportunity would take time, was no means guaranteed, and would require a combination of supportive government policy and action by companies. In particular, the report highlighted that capturing the productivity potential of advanced economies will require a dual focus that promotes sustained demand growth and digital diffusion.

While these trends hold true for the United Kingdom, there are important differences, which we highlight in this paper. In Chapter 1, we describe what has happened to UK productivity growth in the aftermath of the financial crisis and put that in the context of other advanced economies. In Chapter 2, we identify the reasons for the United Kingdom's recent productivity growth slowdown: the role of the financial sector, a focus on adding labour over investment, and gaps in digital adoption, despite overall good digital maturity. Then, in Chapter 3, we outline steps policy makers and companies can take to promote productivity growth.

[5] *Productivity: The route to Brexit success,* McKinsey & Company, December 2016; *Government productivity: Unlocking the $3.5 trillion opportunity,* McKinsey Center for Government, April 2017.

[6] In this paper, we update the time periods to reflect the latest data available (KLEMS 2017 release), and compare productivity growth in the period 2010–15 to that in the period 2000–2005. In our original analysis, we compared the turn of the century (2000–04)—a five-year period before the start of the recent productivity growth slowdown—with the post-recession years (2010–14), a somewhat stable period a decade later (though encompassing the double-dip recession in Europe). While we are aware that choosing specific years involves a degree of arbitrariness, after assessing the pros and cons of multiple different periods, we concluded that concentrating on the period following the crisis allowed us to isolate different factors at the sector level across many different countries more easily. Yet, as explained in footnote 1 above, it also means that in this paper, we do not address in detail the long-term factors behind the United Kingdom's low productivity levels such as infrastructure gaps or poor management practices.

Box 1. The role of mismeasurement in the UK productivity growth slowdown

The measurement of productivity raises many difficult challenges. Output is hard to measure in services, particularly in public services such as health and education. Quality improvements in many areas, especially tech and software, are hard to adjust for accurately. New consumer services, often provided free of charge—such as mobile GPS, search engines, a host of smartphone-based applications, and cloud-based services—have contributed to consumer welfare in ways we are currently not measuring. Nondigital issues, such as globalisation of value chains and profits shifting overseas, and investment in intangibles also contribute to the measurement challenge. These issues indicate that actual productivity is probably higher than measured productivity.

While the amount of mismeasurement is likely to be significant, we find it is not sufficient to explain the full extent of the recent productivity growth slowdown. We identify a broad-based productivity growth slowdown across sectors of the economy, indicating that sector-specific mismeasurement issues cannot fully explain the economy-wide slowdown. We also identify factors that explain the productivity slowdown via clear non-measurement-related channels, as described later in this paper.

Various researchers have attempted to size the portion of the productivity growth shortfall attributable to mismeasurement. A review of the literature suggests that mismeasurement is likely to account for at most a third of the recent slowdown.[1] While much of this literature has focused on the United States, we believe that it provides a guide for the United Kingdom and that the magnitude of the effect would be similar. However, while mismeasurement seems insufficient to explain the economy-wide decline in productivity growth, it can play a role in explaining the decline in specific sectors. For example, work by Byrne and co-authors suggests that accounting for mismeasurement could lead to a smaller decline in productivity growth in the tech sector and a larger decline in other sectors.[2] Research into deflators in the telecom industry finds that they do not include mobile or broadband data, among other issues.[3] Our analysis finds that telecom explains 0.2 percentage point of the 1.9 percentage point productivity growth decline in the United Kingdom. However, adjusting the telecom deflator based on the approach suggested in the research means that telecom would not have contributed to the decline in productivity growth in the United Kingdom. We also discuss the role of measurement in the finance sector in Chapter 2.

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1 See Chad Syverson, *Challenges to mismeasurement explanations for the US productivity slowdown,* NBER working paper number 21974, February 2016. Various authors have suggested a similar conclusion. See Nadim Ahmad, Jennifer Ribarsky, and Marshall Reinsdorf, *Can potential mismeasurement of the digital economy explain the post-crisis slowdown in GDP and productivity growth?* OECD Statistics Working Papers, number 2017/09, July 2017, and Gustavo Adler et al., *Gone with the headwinds: Global productivity,* IMF staff discussion notes, number 17/04, April 2017. Ahmad et al., for example, find that if mismeasurement is occurring, it cannot explain the magnitude of the observed slowdown in GDP or productivity growth. They do caution that this may not be true for future growth as the size of the digital economy increases. David M. Byrne, John G. Fernald, and Marshall B. Reinsdorf have assessed the role played by mismeasurement and find no evidence that mismeasurement has worsened in recent times. Adjusting price deflators for computers, communications and specialised equipment, semiconductors, and software, as well as including intangibles, they find, could add about 0.2 percentage point to US labour productivity growth between 2004 and 2014. However, they believe the mismeasurement contribution from these factors was actually higher—roughly 0.5 percentage point—between 1995 and 2004, because of the higher share of domestic production of many of these products in this period. See David M. Byrne, John G. Fernald, and Marshall B. Reinsdorf, *Does the United States have a productivity slowdown or a measurement problem?* Federal Reserve Bank of San Francisco, working paper number 2016-03, April 2016. Another estimate by Nakamura et al. finds that accounting for free digital content through the lens of a production account would boost productivity growth, but again, not sufficiently to account for the slowdown. Productivity growth would be higher by 0.07 percentage point between 1995 and 2005, and by about 0.11 percentage point between 2005 and 2015. See Leonard I. Nakamura, Jon D. Samuels, and Rachel H. Soloveichik, *Measuring the "free" digital economy within the GDP and productivity accounts,* Federal Reserve Bank of Philadelphia working paper, October 2017. Other research on mismeasurement includes Philippe Aghion et al., *Missing growth from creative destruction,* Federal Reserve Bank of San Francisco working paper number 2017-04, November 2017.

2 See David Byrne, Stephen Oliner, and Daniel Sichel, *Prices of high-tech products, mismeasurement, and pace of innovation,* NBER working paper number 23369, April 2017.

3 Mo Abdirahman et al., "A comparison of approaches to deflating telecoms services output", Economic Statistics Centre of Excellence discussion paper number 2017-04, December 2017.

1. AN INTERNATIONAL COMPARISON

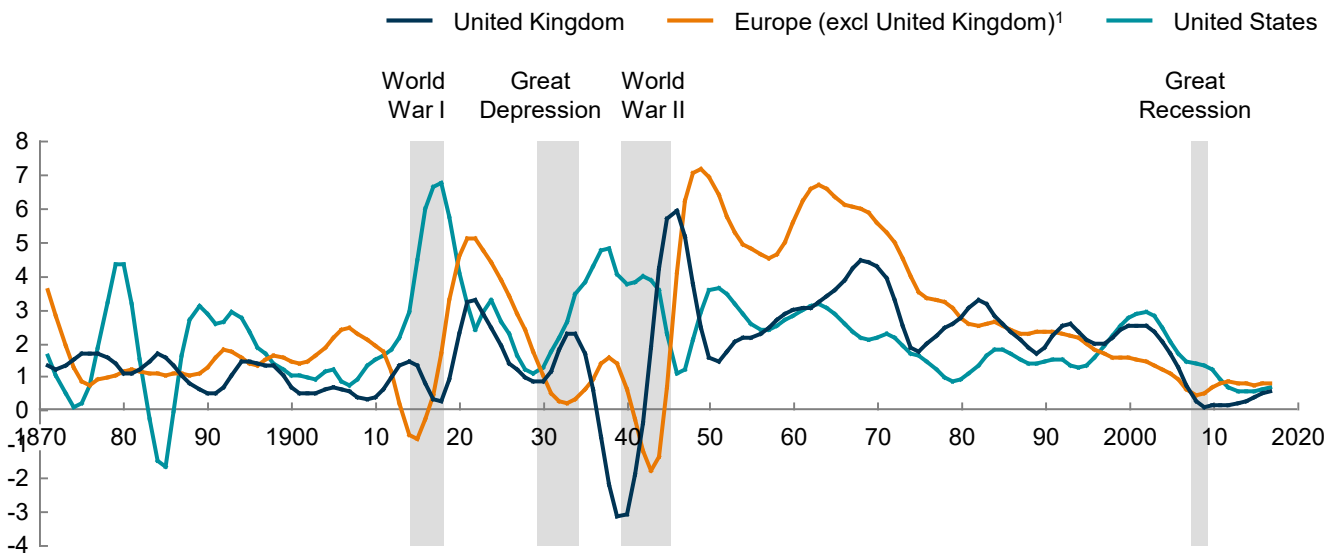
The United Kingdom went into the financial crisis with low labour productivity levels compared to peers.[7] The absolute level of productivity for the United Kingdom in 2007 was about 20 percent lower than for Germany and France and in line with Italy, and these differentials have not changed today. However, this was not always the case. In 1960, UK productivity was higher than France's, but over a 50-year period, productivity diverged as France experienced faster growth in total factor productivity (TFP) and capital investment (see Box 2, "How does the United Kingdom's productivity performance compare to France's?").

Against this backdrop of low absolute productivity, UK productivity growth has remained near historic lows since the financial crisis. Indeed, during the crisis, the decline in productivity growth in the United Kingdom was more severe than in Europe (Exhibit 1).[8] Between 2010 and 2014, UK productivity growth averaged –0.2 percent a year. Since 2014, the productivity picture has improved somewhat, and from 2014 to 2017 productivity growth averaged 0.9 percent a year.[9] Despite this improvement, UK productivity growth remains below that of European peers such as France and Germany.

Exhibit 1

The United Kingdom experienced one of the largest declines in productivity growth following the crisis, although productivity growth has recovered somewhat since 2014.

Trend line of labour productivity growth, total economy
% year-on-year



1 Simple average of France, Germany, Italy, Spain, and Sweden.
NOTE: Productivity defined as GDP per hour worked. Calculated using Hodrick Prescott filter. Drawn from similar analysis in Martin Neil Baily and Nicholas Montalbano, *Why is productivity growth so slow? Possible explanations and policy responses*, Brookings Institution, September 2016.

SOURCE: Antonin Bergeaud, Gilbert Cette, and Rémy Lecat, "Productivity trends in advanced countries between 1890 and 2012", *The Review of Income and Wealth*, Volume 62, Number 3, pp. 420–444; The Conference Board, March 2018 release (for 2017 only); McKinsey Global Institute analysis

7 When we use the term "productivity", we refer to labour productivity, while all other types of productivity—for example, total factor productivity—are spelled out explicitly.

8 Exhibit 1 uses data from Bergeaud, Cette, and Lecat, to allow us to establish a long-term time series. For further details on this data, see Antonin Bergeaud, Gilbert Cette, and Rémy Lecat, "Productivity trends in advanced countries between 1890 and 2012", *Review of Income and Wealth,* September 2016, Volume 62, Number 3. As a result, data in Exhibit 1 do not exactly match data cited elsewhere in this report, which rely on EU KLEMS (2017 release).

9 Based on data from EU KLEMS (2017 release) for data up to 2015 and The Conference Board (March 2018) for 2016–17 data. This is because the EU KLEMS time series terminates in 2015. While there are differences between the databases, both databases show a post-crisis productivity slowdown in the United Kingdom, United States and Europe and an uptick in UK productivity from 2014. For our other analysis in this report, we rely on data from EU KLEMS (2017 release), unless otherwise stated, in order to draw out sector level insights.

Box 2. How does the United Kingdom's productivity performance compare to France's?

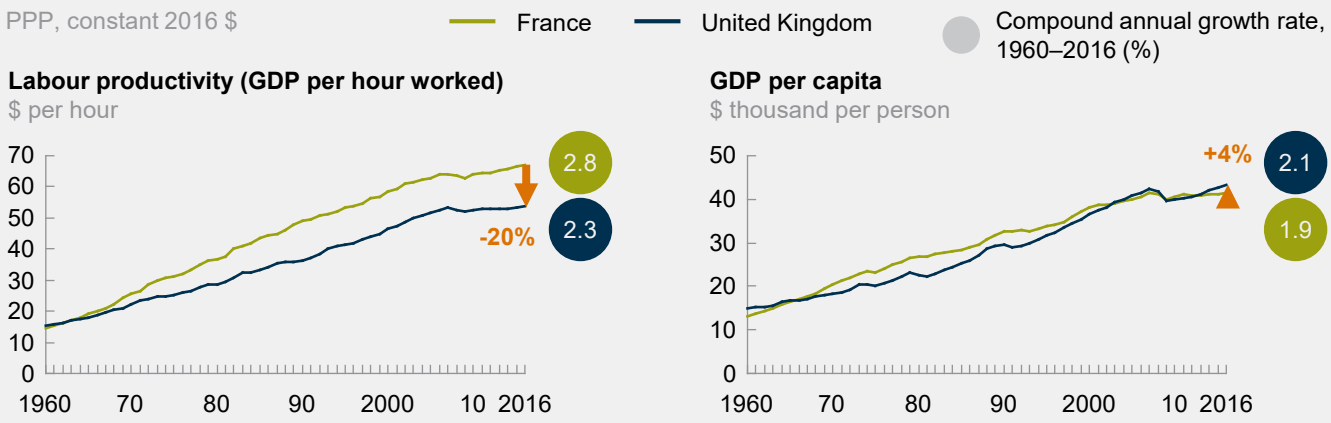
Today UK labour productivity is roughly 20 percent lower than French labour productivity, but this was not always the case (Exhibit 2). Until the 1960s, UK productivity was higher than France's, but then French productivity growth began to pull away and has steadily outpaced UK productivity growth ever since, averaging 2.8 percent a year in France versus 2.3 percent in the United Kingdom.[1] Interestingly, the size of the economy and population are nearly identical, and the mix of sectors is similar. What explains the difference in productivity performance?

Looking across sectors, we found that total factor productivity (TFP) growth in France over the long run was higher than in the United Kingdom. Often used as a proxy for technological progress and innovation, TFP reflects the efficiency with which inputs including labour, capital, energy, materials, and purchased services are combined to produce output. Over the period from 1960 to 2016, lower TFP growth in the United Kingdom accounted for slightly more than half of the productivity growth difference with France, while lower investment growth, measured by growth in capital intensity or capital services per hour worked, accounted for 40 percent.[2]

Despite higher productivity growth in France, GDP per capita, or the amount of goods and services produced divided by the entire population, has remained roughly in line with the United Kingdom. The reason is that beginning in the 1980s, total hours worked grew faster in the United Kingdom than in France, while population growth was slower. This means that to make up for its lagging productivity growth, the United Kingdom has been relying on growth in employment and hours worked to meet its production needs.

Exhibit 2

The United Kingdom's labour productivity diverged from France's in the early 1960s and is now 20 percent lower while GDP per capita has grown in line.



SOURCE: The Conference Board data (March 2018 release); McKinsey Global Institute analysis

[1] The gap reached a maximum of 26 percent in 1990, at which point the United Kingdom began to close the gap, until the financial crisis, when the gap increased again.

[2] Capital intensity is measured as capital services per hour and indicates access to machinery, tools, and equipment. This analysis is based on data from The Conference Board (March 2018 release).

THE UK PRODUCTIVITY GROWTH DECLINE HAS BEEN EVEN BROADER-BASED THAN EUROPEAN PEERS

The United Kingdom's productivity growth slowdown was broad-based across regions and sectors. Every single UK region saw a productivity growth slowdown relative to the period before the crisis. This suggests that, even though productivity levels between regions and local areas in the United Kingdom are very different, the underlying reasons for the productivity slowdown were common across geographies.[10]

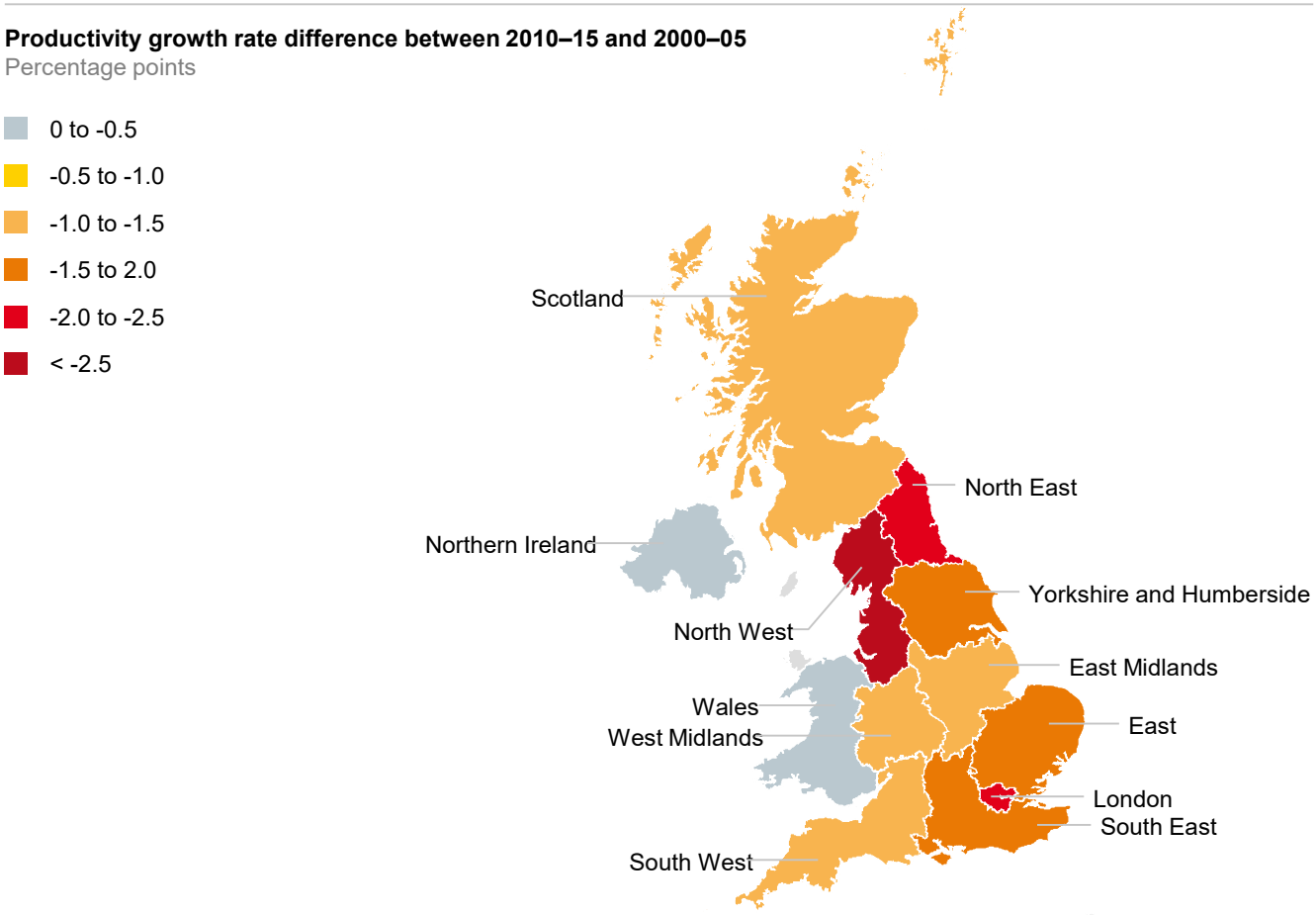
[10] *Unlocking regional growth,* Confederation of British Industry, December 2016. The four main reasons for persistent differences in productivity levels between UK regions and local areas identified in this research were: education and skills, transport links, management practices, and exports. Differential changes between the 2000–05 period and 2010–15 period in these structural factors are likely to have been relatively small due to their long-term nature.

The decline was also broad-based across sectors, with 83 percent (24 of 29 sectors) experiencing a productivity growth slowdown (Exhibit 3). While this was in line with the United States, the slowdown across sectors in the United Kingdom is broader-based compared to its European peers.

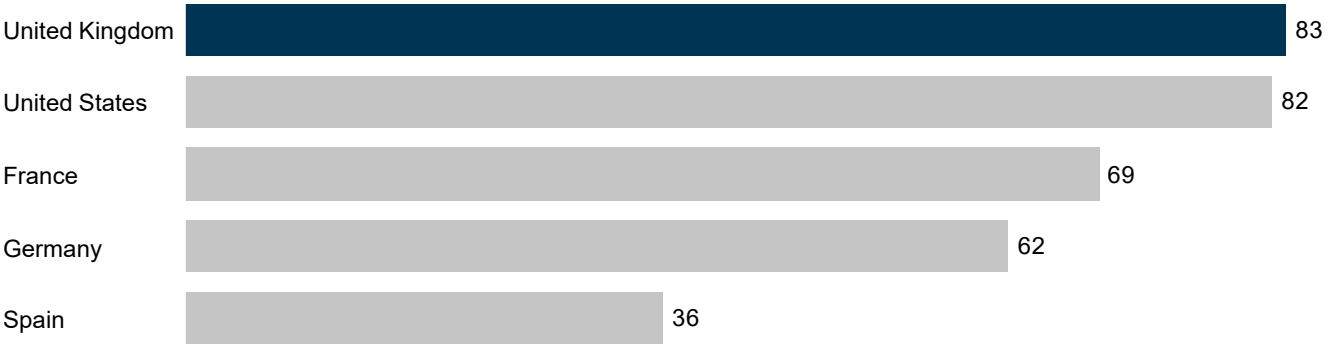
Exhibit 3

In the United Kingdom, every region and 83 percent of sectors experienced a productivity growth decline after the crisis relative to pre-crisis rates.

Productivity growth rate difference between 2010–15 and 2000–05
Percentage points



Share of sectors with lower productivity growth in 2010–15 relative to 2000–05[1]
%



1 All countries are based on 29 sectors except for Spain and the United States, which have 28. Spain does not have specific data for "other service activities", and the United States does not have specific data for "telecommunications". "Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use" is excluded from calculations using KLEMS in this report because of incomplete coverage for countries in our sample.

SOURCE: EU KLEMS (2017 release); ONS; McKinsey Global Institute analysis

THE FINANCIAL SERVICES AND MANUFACTURING SECTORS AND DECLINING TFP GROWTH PLAYED AN OUTSIZE ROLE IN THE UK SLOWDOWN

Although the slowdown was broad-based, finance and manufacturing had an outsize impact relative to their share of the economy in the United Kingdom (Exhibit 4). Despite making up less than 20 percent of UK value added and employment, the decline in productivity growth in these sectors combined accounted for nearly half of the productivity growth slowdown.[11] This reflects the fact that these two sectors were the largest contributors to a wave of particularly strong productivity growth pre-crisis and saw a particularly dramatic slowdown post-crisis. We look at both sectors in more detail in the next chapter.

Labour productivity growth can be decomposed into four factors: capital intensity growth, labour quality growth, total factor productivity growth, and the mix shift effect. Capital intensity is an indicator of access to machinery, tools, and equipment per hour worked. Labour quality measures the impact of changes in factors like education on the productivity of workers.[12] TFP measures the efficiency with which inputs including labour, capital, energy, materials, and purchased services are combined to produce outputs; it is often used as a proxy for technological progress and innovation. Mix shift measures the impact on productivity of changes in the allocation of labour across sectors with different productivity levels.[13] Analysing UK productivity growth through this lens, we find that declining TFP growth was a discernible drag that either did not occur at all in other countries or did not occur to the same extent (Exhibit 5).[14]

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[11] The productivity growth slowdown can be disaggregated into two components: slowdown in productivity growth within individual sectors (a "within" effect), and the impact of reallocation of labour across sectors with different productivity levels and shifts in relative price deflators (a "mix" effect). For the United Kingdom, the total slowdown was 1.9 percentage points, of which 1.4 percentage points was due to within-sector productivity growth slowdown and 0.5 percentage point to the mix effect. The within-sector effect from financial services was a decline of 0.4 percentage point and from manufacturing 0.5 percentage point. The total of these two, a decline of 0.9 percentage point, made up 47 percent of the total slowdown.

[12] Labour quality is typically measured in growth accounting frameworks through the impact of changes in education levels, age, and gender on the efficiency of hours worked. Growth in labour services is calculated as the growth rate of each demographic group, weighted by its share of total wages. Labour quality growth is the difference between growth in labour services and growth in hours worked. For additional details, see EU KLEMS methodological materials.

[13] This analysis is based on the Solow growth accounting framework using data from EU KLEMS. Note that this decomposition is a technical accounting, with capital intensity growth reflecting increases in capital relative to labour, labour quality growth reflecting improvements in labour (for example, through skilling), and total factor productivity growth calculated as the residual once these effects are accounted for. The contribution of capital intensity growth (i.e., capital services per hour worked growth) on labour productivity growth is weighted by the capital share of total income. We have also calculated the contribution from productivity growth of each sector (a "within" effect, which weights the contribution of a sector's labour productivity growth by its share of nominal GDP) and the impact of labour and relative price movements across sectors with different productivity levels (a "mix effect"). This was done using the Generalized Exact Additive Decomposition methodology. See Jianmin Tang and Weimin Wang, "Sources of aggregate labour productivity growth in Canada and the United States", *Canadian Journal of Economics,* May 2004, Volume 37, Number 2, and Ricardo de Avillez, "Sectoral contributions to labour productivity growth in Canada: Does the choice of decomposition formula matter?" *International Productivity Monitor,* fall 2012, Number 24. For further details on capital services, see *Measuring productivity—OECD manual: Measurement of aggregate and industry-level productivity growth,* OECD, 2001.

[14] We also find a substantial negative contribution of –0.5 percent coming from the mix shift effect, namely, the movement of labour from high- to low-productivity sectors. Although there is a long-run trend of employment moving towards low-productivity sectors such as healthcare and education, this trend does not explain the recently observed mix effect. The –0.5 percent is higher than the effect found by other research and explained by the inclusion of the real estate sector in our methodology. The real estate sector has a disproportionately high productivity level as measured in national accounts using the imputed rent approach—in the United Kingdom, for example, it had more than seven times the productivity level of the total economy in 2015. In the 2000–05 period, labour shifted fast towards the real estate sector, while the pace slowed post-crisis. Given the high measured productivity level of the sector, small changes in the rate of labour movement to or from the sector yield large mix shift effects, like the one we observe. For more about imputed rents and the real estate sector, see also Rebecca Riley, Ana Rincon-Aznar, and Lea Samek, "Below the aggregate: A sectoral account of the UK productivity puzzle," Economic Statistics Centre of Excellence discussion paper number 2018-06.

Exhibit 4

The most important sectors contributing to the United Kingdom's productivity growth decline were manufacturing, financial services, and information and communication services.

Sector contribution to productivity growth difference between 2000–05 and 2010–15[1]
Percentage points

< -0.2 | -0.2 to 0 | 0 to 0.2 | > 0.2

		France	Germany	Spain	United Kingdom	United States
Primary	Agriculture, forestry and fishing	0.0	-0.1	0.1	0.0	-0.1
	Mining and quarrying	0.0	0.0	0.0	-0.1	0.2
	Electricity, gas and water supply	0.0	-0.1	-0.1	-0.1	0.0
Manufacturing	Total manufacturing	-0.3	-0.4	0.1	-0.5	-0.9
Boom/bust	Financial and insurance activities	0.0	0.3	-0.4	-0.4	-0.2
	Real estate activities	0.1	-0.3	0.4	0.3	-0.2
	Construction	-0.1	0.0	0.5	0.0	0.0
Consumer-facing services	Wholesale and retail trade; repair of motor vehicles and motorcycles	0.2	-0.2	0.2	-0.1	-0.3
	Transportation and storage	0.0	-0.2	0.3	-0.1	-0.1
	Accommodation and food service activities	0.0	0.0	0.2	-0.1	0.0
High-skilled and support services	Information and communication services	-0.2	0.1	-0.1	-0.3	-0.5
	Professional, scientific, technical, administrative and support service activities	0.0	0.1	0.5	-0.1	-0.1
Other private services	Arts, entertainment, recreation, and other service activities	-0.1	0.0	0.0	0.0	0.1
Public or quasi-public services	Public administration and defence; compulsory social security	-0.1	0.0	-0.1	0.0	0.0
	Education	0.1	0.0	-0.1	0.0	0.0
	Health and social work	0.0	-0.1	0.0	0.0	0.0
Total contribution of the productivity growth decline in each sector		-0.4	-0.7	1.3	-1.4	-2.1
Total contribution of the mix shift across sectors		-0.1	-0.1	-0.2	-0.5	-0.3
Total economy productivity-growth decline		-0.5	-0.8	1.1	-1.9	-2.4

1 Based on the contribution of the productivity growth decline in each sector.

SOURCE: EU KLEMS (2017 release); McKinsey Global Institute analysis

Exhibit 5

Productivity growth declined 1.9 percentage points in the United Kingdom, with total factor productivity playing a large role in the decline.

Growth rates and contributions by country
Percentage points

Low or no effect | Moderate effect | Large effect

Decline in productivity growth

		United States	United Kingdom	Germany	France	Spain
Productivity	Change in growth, 2010–15 vs 2000–05	-2.4	-1.9	-0.8	-0.5	1.1
	Growth, 2000–05	2.2	2.0	1.6	1.4	0.0
	Growth, 2010–15	-0.2	0.2	0.8	0.8	1.1
Gross value added	Change in growth, 2010–15 vs 2000–05	-0.6	-0.8	0.8	-0.6	-3.3
	Growth, 2000–05	2.2	2.7	0.7	1.6	3.1
	Growth, 2010–15	1.6	1.9	1.5	1.0	-0.2
Hours worked	Change in growth, 2010–15 vs 2000–05	1.8	1.0	1.5	-0.1	-4.4
	Growth, 2000–05	0.0	0.7	-0.9	0.2	3.1
	Growth, 2010–15	1.8	1.7	0.7	0.2	-1.3
Contribution of factors to change in productivity growth	Capital intensity	-1.3	-0.4	-0.7	-0.5	0.5
	Labour quality	-0.1	0.1	-0.2	0.2	0.3
	Total factor productivity	-0.7	-1.1	0.3	-0.1	0.5
	Sector mix effect	-0.3	-0.5	-0.1	-0.1	-0.2
Top sectors contributing to the decline in productivity growth	Arts, entertainment, recreation, and other services				●	
	Electricity, gas and water supply					●
	Financial and insurance activities		●			●
	Information and communication services	●	●		●	●
	Real estate activities			●		
	Manufacturing	●	●	●	●	
	Transportation and storage			●		
	Retail and wholesale trade	●				

NOTE: Figures may not sum because of rounding.

SOURCE: EU KLEMS (2017 release); McKinsey Global Institute analysis

Out of the 1.9 percentage point decline in the UK productivity growth rate, 1.1 percentage points were due to declining TFP growth, while declining capital intensity growth was responsible for 0.4 percentage point.[15] The decline in productivity growth in both the financial and manufacturing sectors, together with ICT services (which suffers from some measurement issues), underpin the more significant role of declining TFP growth in the United Kingdom compared with other countries. We calculate that the financial sector accounted for about one third of the total decline in TFP growth, manufacturing a quarter, and information and communications another quarter. We return to the causes of these patterns in the financial and manufacturing sectors in the next chapter.

2. REASONS FOR THE UK SLOWDOWN

While most countries in our sample experienced a productivity growth decline across sectors, associated with declining capital intensity and TFP growth, the United Kingdom's broader-based and more extreme decline in labour productivity and TFP growth indicate that the underlying dynamic is somewhat different. In this chapter we outline that dynamic to explain why productivity growth slowed more sharply in the United Kingdom than in other European countries.

To start, the impact of the boom/bust cycle in the financial sector was far more significant, accounting for about 20 percent of the aggregate productivity growth slowdown in the United Kingdom. Then, in the aftermath of the crisis, the extent of employment growth across regions and sectors in the United Kingdom was well ahead of European peers, with companies on average prioritising additional labour over investment to meet demand. Finally, while digitisation is underway across countries, with significant potential to boost productivity growth, it is happening unevenly across industries and firms, and it comes with adoption barriers, lags, and transition costs. The United Kingdom is no exception. While the United Kingdom does well in internet access, basic digital skills, and the adoption of cloud computing, it ranks poorly in other areas, especially the integration of information systems across the value chain and across entire business processes, as well as the adoption of robotics.

THE BOOM/BUST CYCLE IN FINANCE PLAYED A MORE SIGNIFICANT ROLE IN THE UK PRODUCTIVITY GROWTH SLOWDOWN THAN IN EUROPE OR THE US

The impact of the boom/bust cycle in the financial sector on the UK slowdown was far more significant than in other countries. Annual financial sector productivity growth slowed 6.1 percentage points in the United Kingdom in the post-crisis period compared with the pre-crisis period, more than double the slowdown in the US financial sector (Exhibit 6). The decline in productivity growth in the financial sector accounted for about 20 percent of the aggregate productivity growth slowdown in the United Kingdom.[16] Even in the United States, which also experienced a significant boom/bust cycle, the financial sector accounted for only about 10 percent of the productivity growth slowdown. This outsize impact cannot be explained by the size of the financial sector compared to the rest of the economy. In the United Kingdom, finance represents 6.9 percent of the total economy, while in the United States, it represents 7.4 percent.

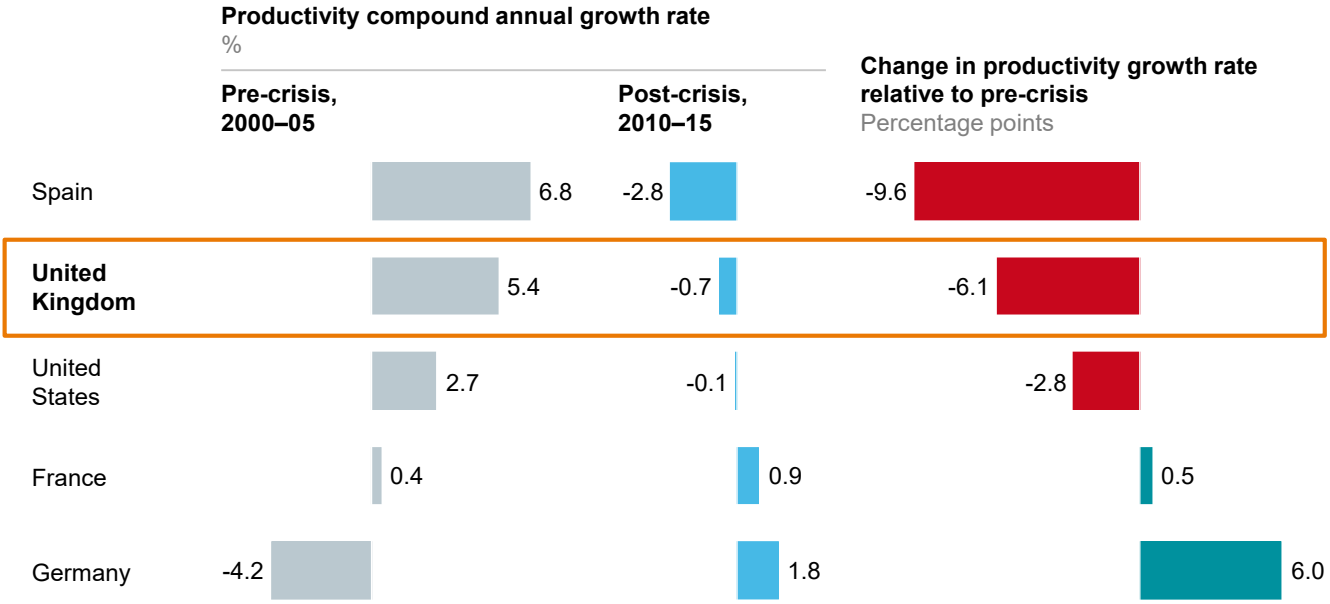
[15] EU KLEMS (2017 release) data contain some internal inconsistencies to do with capital intensity figures across different parts of the database. Some of the figures are inconsistent with other databases such as The Conference Board and the ONS. Hence, we have slightly adjusted EU KLEMS figures in order to make them internally consistent, which in turn brings them closer to the other databases. The changes are not material and only slightly affect the magnitude of capital intensity, TFP, and labour quality estimates. The direction of these estimates is consistent across databases, including EU KLEMS.

[16] Financial-sector productivity growth declined by 0.4 percentage point, while the aggregate productivity growth slowdown was 1.9 percentage points. As shown in Exhibit 4, the aggregate consists of two effects: the total sum of the individual contributions of all the sectors, which accounts for 1.4 percentage points, and labour movements across sectors, which account for 0.5 percentage point.

Exhibit 6

The productivity growth slowdown in the United Kingdom's financial sector was more severe than in most other countries.

Financial sector



SOURCE: EU KLEMS (2017 release); McKinsey Global Institute analysis

The outsize impact of finance in the case of the UK productivity growth slowdown is partly due to the extent of the boom ahead of the financial crisis. In the period 2000 to 2005, productivity growth in the financial sector in the United Kingdom was on average 5.4 percent a year, compared with 2 percent in the economy as a whole. This boost was associated with accelerating value-added growth as loan and deposit volumes grew, helped by leverage. Productivity growth in finance during this time was the strongest out of all UK sectors and the highest among peers, except Spain. Then came the crisis, and with it a significant demand shock to the financial sector, leading to a large drop in value-added growth, while hours growth could not be readily adjusted to match. The result was a severe decline in productivity growth to an annual average of –0.7 percent a year in the 2010 to 2015 period, a drop of 6.1 percentage points. While it is likely that measurement issues have played some role in this slowdown, there is also clear evidence of a decline in volume growth (see Box 3, "What drives measured value added in the financial sector?").

The United Kingdom experienced the second-highest increase in loan and deposit volumes in the run-up to the financial crisis out of its peers, behind only Spain (Exhibit 7). It also experienced the longest sustained increase in bank leverage. Yet hours worked in the sector did not grow commensurately: only 2 percent in the United Kingdom over the period 2000 to 2007 compared to 8 percent in the United States over the same period. While technology is likely to have contributed to banks' efficiency, banks can also increase output in other ways without materially increasing labour hours. For example, larger loans or higher loan-to-value ratios translate into higher value added and do not necessarily involve more hours worked.[17]

[17] The average loan-to-value ratio was 89 percent in 2000–05, 81 percent in 2010–15, and as low as 75 percent in 2009. This means that, for example, for the same property (assuming constant prices), a bank would give a smaller loan post-crisis.

Box 3. What drives measured value added in the financial sector?

The measurement of value added is a crucial part of calculating productivity statistics. For many sectors, it is relatively straightforward to define what goods or services are produced, what price consumers pay for them, and how much of the change in prices is due to inflation versus quality changes. Multiplying the amount of goods and services by the respective deflated prices then produces a measure of real (inflation-adjusted) value added. Financial services, however, is a more challenging sector to measure in this regard.

Financial institutions offer a range of services such as payment settlement, risk transfer, advisory services, and intermediation. Some are relatively easy to quantify, since financial institutions charge an explicit price or fee for them. That fee is treated like the price of any other good or service, and hence can be used to calculate value added. Others are harder to measure. For example, financial intermediation (taking deposits from some customers and lending this money forward to other customers) accounts for around 40 percent of banking gross value added. In this case, when a customer deposits her savings in a bank, the bank does not charge an explicit fee. However, it is providing various services to that customer, the most obvious being safekeeping. Similarly, while a bank may charge a fee for extending a loan to a customer, a larger proportion of the profits from its loan book are typically derived from charging interest on the loans, which partly account for the service of connecting lenders and borrowers the bank is providing.

Measured value added attempts to size these intermediation services. Consequently, it fluctuates with the volume of intermediation services, namely, of loans and deposits, a point also made by the Bank of England.[1] Additionally, many of the services financial institutions charge for are directly or indirectly related to borrowing and lending, such as credit cards. For all these reasons, the boom/bust pattern observed in the financial sector is likely to be largely explained by the increase and decrease of loan and deposit volumes and related dynamics in the volume of other banking services.

The Bank of England, however, argues that the contribution of finance to GDP could be exaggerated by some challenges intrinsic to the most common technique used in national accounts to measure value added of intermediation services, known as financial intermediation services indirectly measured, or FISIM. The Bank of England points to various challenges such as choosing the reference rate necessary for the calculations, deflating variables, and measuring quality changes in banking services.[2] It also finds that measured value-added growth in finance could be influenced by changes in risk-taking.[3] This raises questions about whether the pre-crisis boom in the financial sector in the United Kingdom might have been inflated by mismeasurement.

The Bank of England calculates that actual FISIM in the Euro-area countries, when adjusted for risk-taking, may have been up to 40 percent lower in the 2003 to 2007 period than the FISIM recorded in national accounts. Although this seems large, FISIM itself represents only 40 percent of value added in the banking sector, and the banking sector in turn does not represent the entire financial sector, but around 60 percent of it. This means that errors in measurement, while likely to be present, are not large enough to explain the entire slowdown in productivity growth in the sector.

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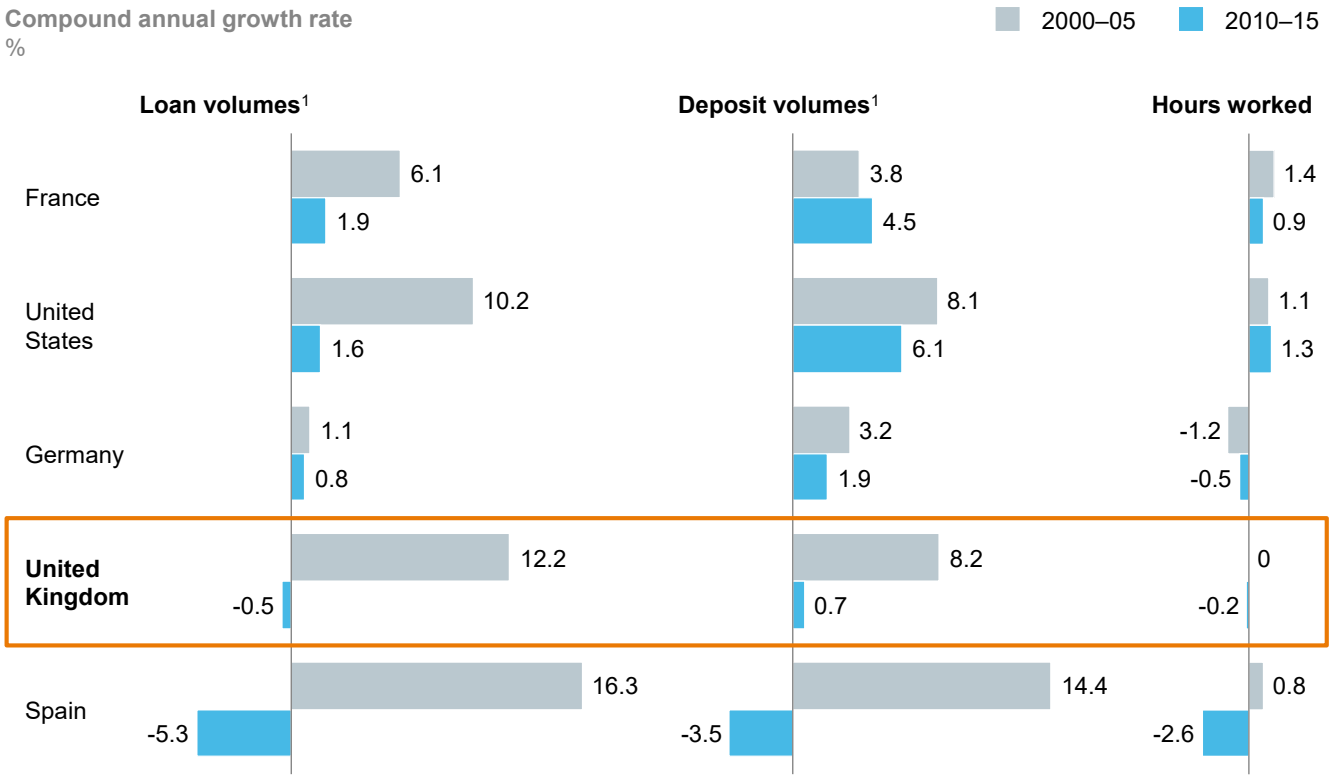
1 Silvana Tenreyro, *The fall in productivity growth: Causes and implications,* Bank of England, 2018.

2 See *Measuring financial sector output and its contribution to UK GDP,* Stephen Burgess, Bank of England, 2011, for percentages of different components of gross value added in the banking industry and a more detailed explanation of some of the concepts and measurement challenges outlined here.

3 Andrew Haldane, Simon Brennan, and Vasilieos Madouros, "What is the contribution of the financial sector: Miracle or mirage?" in *The Future of Finance: The LSE Report,* London, England: London School of Economics and Political Science, 2010.

Exhibit 7

The United Kingdom's financial sector experienced a sharp boom and bust in loan and deposit volumes, while financial institutions did not adjust hours worked proportionately.



1 Local nominal currency units.
NOTE: Sorted by growth in loan volumes in 2010–15.

SOURCE: EU KLEMS (2017 release); McKinsey Panorama; McKinsey Global Institute analysis

After the crisis, when loan and deposit volume growth fell, UK banks could not readily reduce hours worked to match that decline. For example, loan volume growth dropped from a rate of 12 percent pre-crisis to –1 percent post-crisis, but from 2010 to 2015, UK banks reduced hours worked by only 0.2 percent a year.[18] High fixed costs in banking, such as IT infrastructure and branch networks, make it hard to reduce staff quickly in the face of declining loan and deposit volumes. The cost-to-income ratio in UK financial services increased from 63 percent in 2005 to 70 percent in 2016, driven mainly by increases in non-staff operating costs, while growth in income remained relatively stagnant, particularly between 2010 and 2015.[19] In addition, banks needed to add staff in response to regulatory changes, particularly in areas involving risk and compliance.[20]

[18] UK financial firms did cut employment immediately following the crisis, although the reduction was less than that seen in the United States. Hours worked decreased 3 percent in the United Kingdom in 2007 to 2010 while it dropped 7 percent in the United States during the same period.

[19] *Monetary financial institutions' annual profit and loss,* Bank of England, March 2018.

[20] Martin Arnold, "HSBC wrestles with soaring cost of compliance", *Financial Times,* August 4, 2014; Tom Braithwaite, "Bubble could burst on boom in bank compliance units", *Financial Times,* April 6, 2015; Laura Noonan, "Banks face pushback over surging compliance and regulatory costs", *Financial Times,* May 28, 2015.

The outsize role of finance in the UK productivity growth slowdown also helps explain the large drop in the UK's TFP growth, a drop that was not common in peer countries. A typical explanation behind slowing TFP growth is declining innovation rates. We do not find evidence of this in the period analysed. R&D investment in the United Kingdom did not fall after the crisis; in fact, it increased slightly. Additionally, government data on the percentage of UK firms that innovate in their products and processes showed that these numbers declined immediately following the crisis and began to recover after 2012.[21] Instead, the boom/bust cycle in finance helps explain the large drop in TFP growth. In the short run, TFP growth captures business cycle fluctuations, and therefore value-added fluctuations, which were particularly prevalent in finance. Out of the total decline of 1.1 percentage points in total TFP growth in the United Kingdom from the pre-crisis to post-crisis period, 0.4 percentage point is attributable to the financial sector.[22]

Looking ahead, financial-sector productivity growth is unlikely to decline as much as it did after the crisis, when it dragged down the whole economy. Assuming another shock does not hit finance, productivity in this sector should keep improving. However, it is also unlikely to return to pre-crisis growth rates over a sustained period, as those high rates were partially the reflection of excess leverage and risk-taking. Therefore, in order for the United Kingdom to return to pre-crisis productivity growth rates, other sectors will have to make up for finance.

GROWTH IN HIRING WAS FAR AHEAD OF EUROPEAN PEERS AND EXCEEDED PRE-CRISIS RATES, CREATING AN EMPLOYMENT PUZZLE

As demand recovered after the crisis, UK firms hired labour nearly as fast as output grew across regions and sectors, rather than investing in capital or improving efficiency. This focus on employment over investment acted as a broad-based drag on productivity growth. Why did UK firms add hours at such a high rate while demand growth recovered only moderately? We believe explaining this "employment puzzle" is key to understanding the UK productivity growth slowdown. Below, we describe the two key dynamics at play: an expansion in flexible and affordable labour supply; and uncertainty, which favoured hiring additional workers instead of making capital investments.

A decomposition of labour productivity into its two components—value added as the numerator and hours worked as the denominator—shows the United Kingdom stands out for having the strongest growth in hours worked in Europe in recent years.[23] The United Kingdom experienced post-crisis hours worked growth of 1.7 percent a year compared to 0.7 percent in Germany and 0.2 percent in France. Value-added growth in the United Kingdom also slowed from 2.7 percent a year pre-crisis to 1.9 percent a year post-crisis. The United Kingdom's value-added growth rate of 1.9 percent, while lower than pre-crisis, was relatively healthy compared with the 1.2 percent average growth across our sample.

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21 The proportion of firms innovating in their processes fell from 12.6 percent in 2006–08 to 10.3 percent in 2008–12, but then recovered to 12.8 percent in 2012–14. Product innovators fell from 23.9 percent of firms in 2006–08 to 18 percent of firms in 2010–12 before improving to 19.2 percent in 2012–14. *UK innovation survey 2013: First findings,* Department for Business, Innovation and Skills, April 2014.

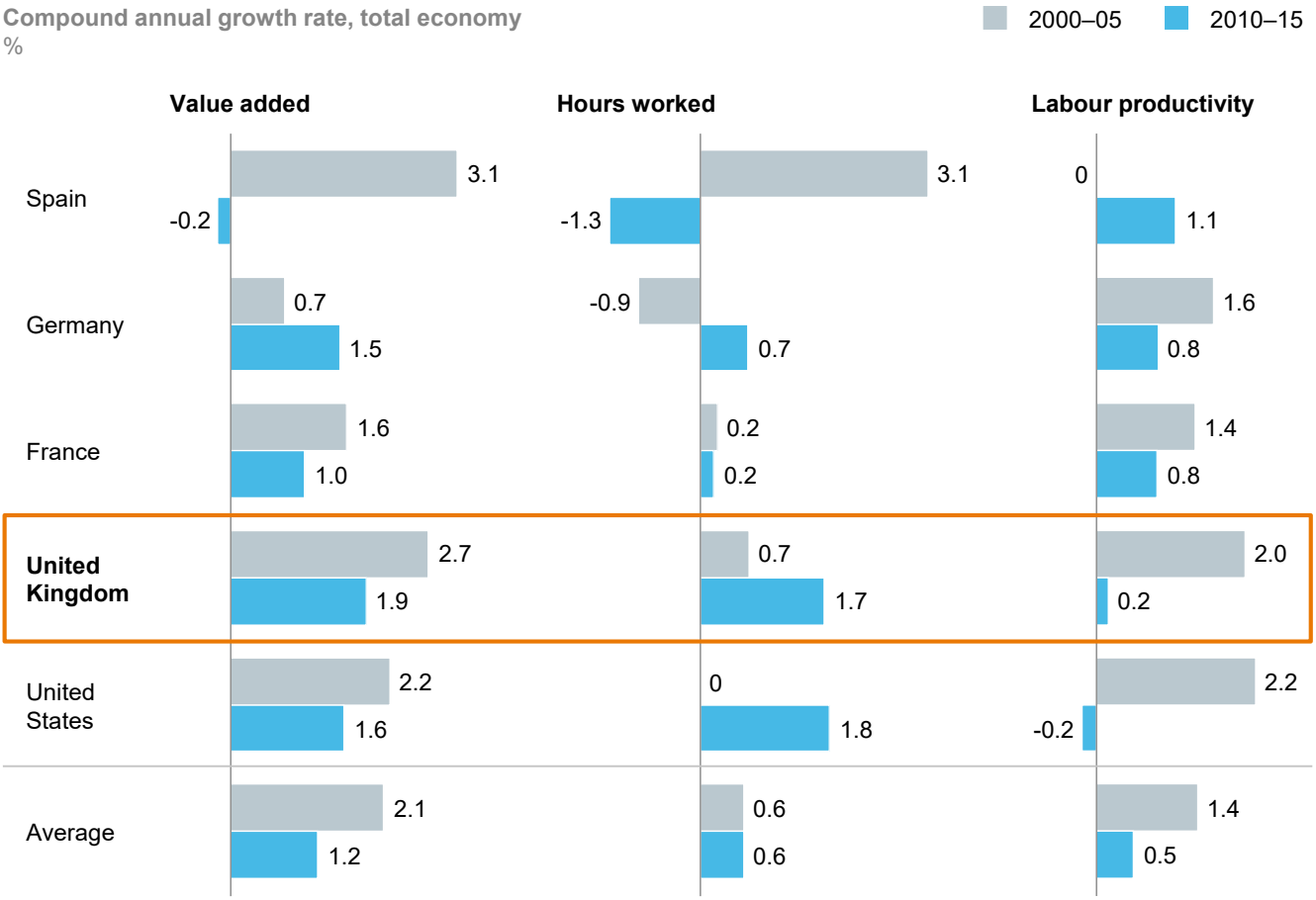
22 The financial sector may have also contributed to the decline in TFP growth in other sectors for a prolonged period, according to the so called "TFP hysteresis" effect. After a financial crisis, when both financial institutions and corporations have weak balance sheets and uncertainty is pervasive, tight credit conditions and capital misallocation can damage TFP growth for several years, even after the demand shock is over. See Adler et al., *Gone with the headwinds: Global productivity,* IMF staff discussion note number 17/04, April 2017.

23 Improvements in productivity can be achieved by boosting efficiency—in other words, reducing inputs for a given output—or increasing the volume or value of output for any given input. An economy needs to spur both robust growth and prosperity. Efficiency gains are important not only for cost competitiveness at the company, sector, and national levels and for providing consumers with affordable goods and services, but also for facilitating the movement of labour and capital to new and growing sectors. Meanwhile, value-added growth—increasing the quality and volume of goods and services—facilitates a virtuous cycle of growth whereby increases in value added are associated with rising incomes, which in turn fuel demand for more and better goods and services.

For example, in France value-added growth was 1.0 percent, in Germany 1.5 percent, and in Spain –0.2 percent. The United Kingdom's strong hours worked growth and moderate decline in value-added growth were associated with a 90 percent slowdown in productivity growth between the two periods, from 2 percent a year before the crisis to 0.2 percent after the crisis (Exhibit 8).[24]

Exhibit 8

Flat productivity growth between 2010 and 2015 in the United Kingdom was associated with falling value-added growth and stronger hours worked growth.



NOTE: Sorted by fastest to slowest productivity growth in the 2010–15 period.

SOURCE: EU KLEMS (2017 release); McKinsey Global Institute analysis

The increase in hours worked growth reflected not merely a rebound from the financial crisis but additional hiring, especially among the young and old. Today the UK employment rate stands at a 50-year high.[25] Hours worked growth in the period after the financial crisis was about three times the average rate of our sample of advanced economies. Both labour supply and demand factors contributed to this "employment puzzle". In an environment of increased employment and flexibility of the labour market, wages also were low. This in turn

[24] The United States saw a more significant contraction in hours worked during the crisis, which explains some of the post-crisis increase; however, as in the United Kingdom, hours worked were still higher after the crisis than before.

[25] There is a stronger cyclical effect among younger workers where the employment rate dropped sharply post-crisis. As we note below, even among younger workers, the UK's employment rate is now the highest in our sample.

encouraged companies to hire labour instead of investing in capital—especially in the post-crisis environment of uncertainty.[26]

Employment increased, particularly among the young and old, likely influenced by policy changes around apprenticeships, university fees, and pensions

We find a trend of stronger hours worked growth that exceeded pre-crisis levels across 76 percent of sectors in the United Kingdom, mainly from jobs growth. Two million new employees entered the workforce between 2010 and 2015. While growth in employment was strong across all age groups, it was particularly noticeable among the young and the old (Exhibit 9). Sixty percent of jobs growth came from people who were 29 and under or 55 and over. From 2010–15, employment grew 7 percent for those who were 29 and under and 15 percent for those who were 55 and over versus 5 percent for those aged 30–54.[27] Among people aged 15 to 24 and 25 to 34, the UK employment rates are now the highest in our sample of countries, at 54 and 82 percent, respectively.[28] Indeed, UK employment rates for people under 34 years old are above the rates in both Sweden and Germany, which have some of the highest employment rates in Europe. Interestingly, we also find that among the young and old, literacy and numeracy skills tend to be lower than for the middle-age category, potentially indicating the need for further skilling going forward. While changes in labour quality did not act as a drag on productivity growth between the pre- and post-crisis periods, the basic skill levels of the workforce can play a role in impacting labour productivity levels. In the context of future technological transitions, ensuring the broad population has the appropriate skills will be an important area for the United Kingdom to focus on as it looks to boost productivity.

These labour supply dynamics may have been influenced by policy initiatives such as new apprenticeships, an increase in the state pension age, and rising university tuition fees.[29] The number of apprenticeship starts in England increased significantly, from 240,000 in 2008 to 510,000 in 2012.[30] Raising the university fee cap to £9,000 in 2012 encouraged more young people into the workforce post-crisis. That year, 52,000 fewer students applied to UK universities, a cohort dominated by those under the age of 25.[31] Although growth in applications has continued since then, it has been slower, potentially linked to increased preferences to join the labour force instead. In addition, from 2010 to 2015, the number of people 55 and over in the labour force increased by about 800,000. Older people are working longer. Partly, that may have to do with an increase in the state pension age for women to 65, although we find the trend affects men as well as women.

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[26] One possible reason for low growth in wages is that workers are switching jobs less than in the past. Job-to-job moves are important for pay progression, and even today the proportion of workers voluntarily moving from one job to another is lower than at any point between 2000 and 2008. For more information, see "The Resolution Foundation Earnings Outlook: Job-to-job moves", Resolution Foundation.

[27] Although employment growth for the older cohort in part reflects a larger number of older workers due to population ageing, the employment rate also grew. For example, the employment rate for 65–80-year-olds grew from 10 to 13 percent over the period.

[28] Age bands may differ throughout the paper because we use ONS data for our UK employment analysis and OECD data for country comparisons.

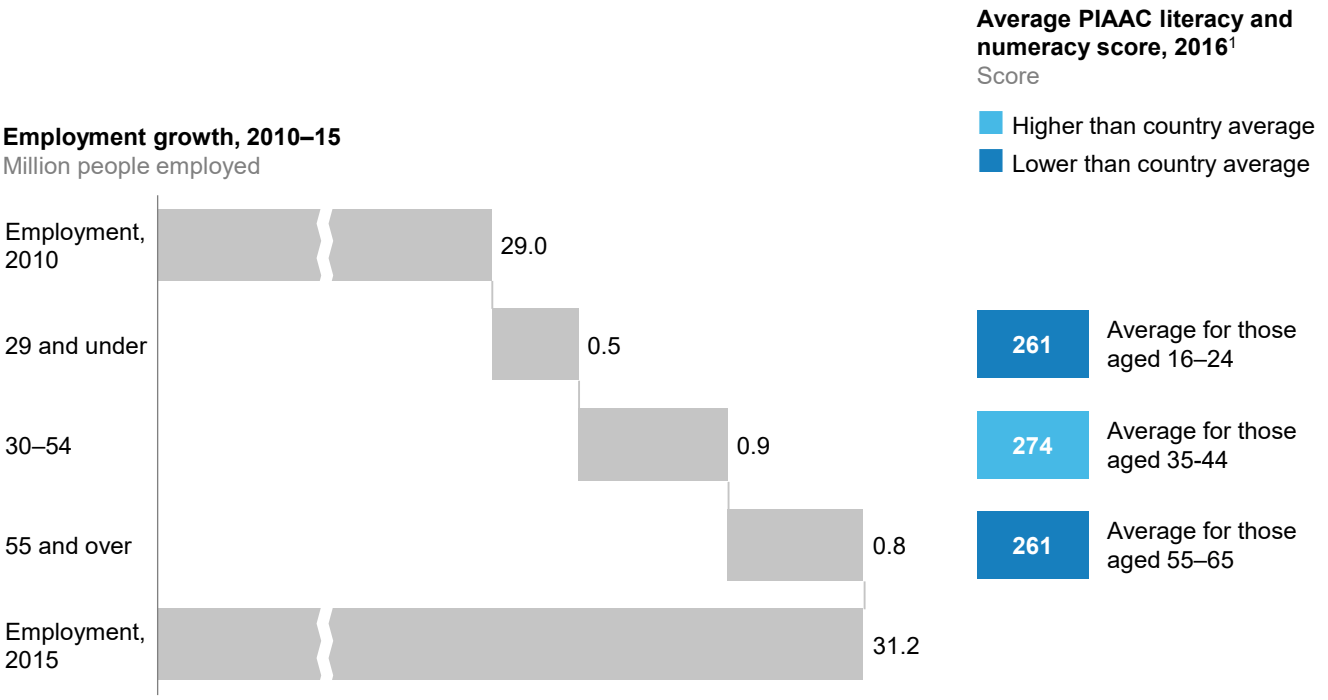
[29] Another policy change that may have encouraged an increase in the supply of low-income workers is the strong increase in tax credits relative to GDP since the early 2000s, mainly due to an extension of the number of people eligible for the working tax credit and more generous child tax credits. Because the increased spending on tax credits pre-dated the financial crisis, this is unlikely to explain the productivity slowdown, although it is another possible driver of the United Kingdom's high employment rate.

[30] Andy Powell, "Apprenticeship statistics for England", House of Commons Library, January 2018.

[31] Paul Bolton, "Entrants to higher education", House of Commons Library, October 2013.

Exhibit 9

More than two million more people were employed between 2010 and 2015, with high growth among the old and young; these age groups have lower literacy and numeracy skills than the middle age category in the United Kingdom.



1 Programme for the International Assessment of Adult Competencies (PIAAC). Average for all age groups is 267.

SOURCE: ONS; OECD; McKinsey Global Institute analysis

The low-wage-growth environment reinforced the attractiveness of labour over capital, especially at a time of heightened uncertainty

Low growth in wages reinforced the attractiveness of labour over capital in an environment of labour market flexibility and heightened uncertainty. In such circumstances, firms tend to meet output growth by hiring new workers or increasing the hours of existing workers. This is because investment in capital goods is harder to reverse than adding workers.[32] New plant equipment, for example, cannot be returned to the seller if conditions change. This phenomenon was echoed in our interviews with corporate leaders. One manufacturing executive explained that labour market flexibility typically meant that capital investment plans would be put on hold during periods of heightened uncertainty. We find that uncertainty has increased significantly in the United Kingdom, first in 2010 due to the continuing political and economic crises in the European Union, and then following the Brexit vote (Exhibit 10). From surveys of European business leaders, we have found that uncertainty is the key factor holding back investment in Europe.[33] UK firms stand out in those surveys as being particularly pessimistic about the investment outlook and concerned about regulatory uncertainty. About 20 percent of UK companies cited various forms of uncertainty as a main reason for not investing.[34]

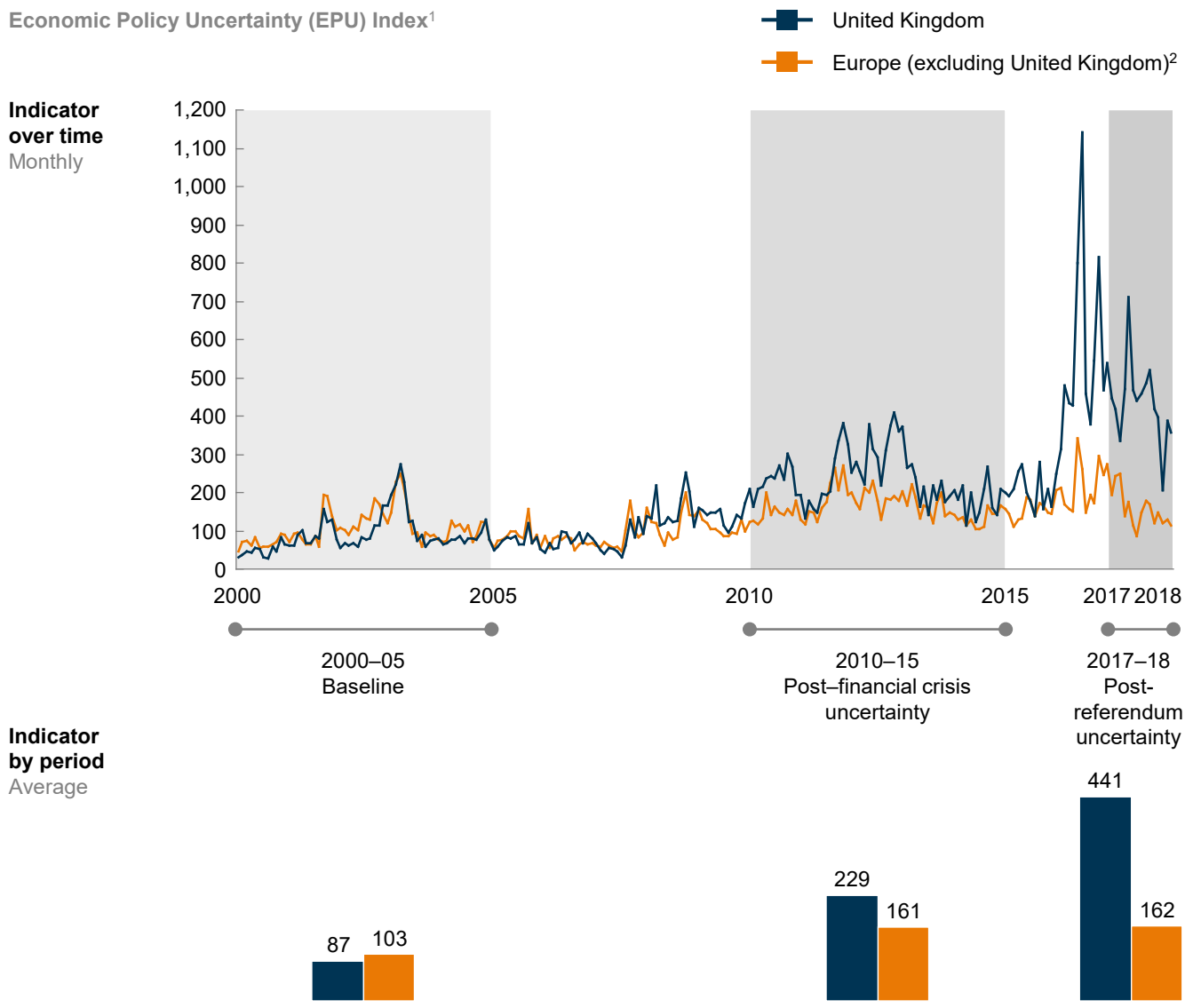
32 Nicholas Bloom, "The impact of uncertainty shocks", *Econometrica*, Volume 77, 2009.
33 *European business: Overcoming uncertainty, strengthening recovery,* McKinsey Global Institute, May 2017.
34 McKinsey Global Institute Business Survey, 2017.

UK INVESTMENT WAS LOW RELATIVE TO PEERS AHEAD OF THE CRISIS AND FELL FURTHER AFTER IN EQUIPMENT AND STRUCTURES

After the crisis, as companies met growth in demand through increased hiring, investment fell due to a combination of a low demand environment, overcapacity, and uncertainty, creating a job-rich but investment-weak recovery. Capital services per hour growth in the United Kingdom fell even further as the growth in hours worked diluted the available capital base per hour worked. In the United Kingdom, the contribution of capital services per hour growth to productivity growth fell from a pre-crisis average of 0.3 percent to –0.1 percent in the post-crisis period. Therefore, the drop in the growth of capital intensity contributed 0.4 percentage point to the United Kingdom's overall 1.9 percentage point slowdown in productivity growth, as shown in Exhibit 5 earlier.

Exhibit 10

Uncertainty in the United Kingdom was higher after the financial crisis compared to Europe and has increased further since the Brexit referendum.



1 Each national EPU Index reflects the relative frequency of own-country newspaper articles that contain a trio of terms pertaining to the economy, policy, and uncertainty. In other words, each monthly national EPU Index value is proportional to the share of own-country newspaper articles that discuss economic policy uncertainty in that month.
2 Average of France, Germany, Italy, and Spain.

SOURCE: Economic Policy Uncertainty Index; McKinsey Global Institute analysis

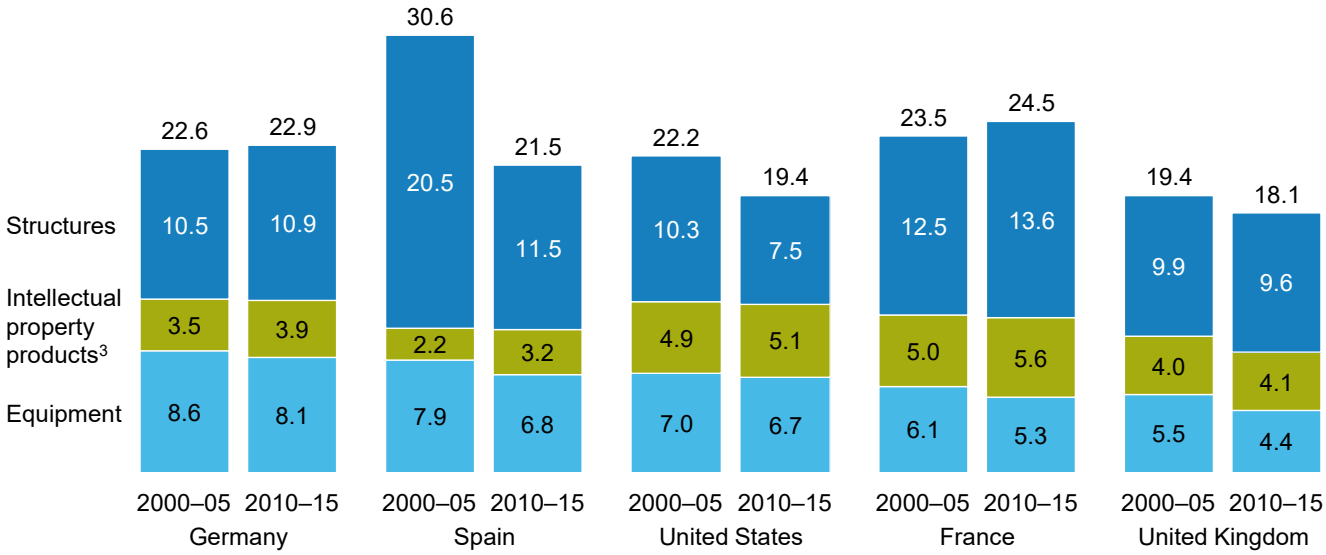
Other measures of investment provide further evidence of the job-rich, investment-weak recovery. Gross fixed capital formation in the United Kingdom was low relative to other countries in our sample going into the financial crisis and fell further in the aftermath. Average gross fixed capital formation as a share of gross value added fell from 19.4 percent to 18.1 percent between 2000–05 and 2010–15. This is significant not only because the rate of capital accumulation fell, but also because the level of investment was the lowest across comparable countries.

Breaking down investment into components, we find that investment as a share of gross value added fell in equipment and structures while investment increased in intangibles such as software and R&D (Exhibit 11).[35] Equipment investment is one of the key drivers of the overall low levels of investment in the United Kingdom compared with other countries, both pre- and post-crisis. This is particularly relevant because of equipment's role in automation. Indeed, weak equipment investment played a key role in declining productivity growth in manufacturing (see Box 4, "How stronger hiring and weaker investment explain a productivity growth decline in manufacturing"). We find that the manufacturing sector accounted for about half of the decline in equipment investment between the pre- and post-crisis periods.

Exhibit 11

The United Kingdom has a low level of both overall and equipment investment and experienced the sharpest decline in equipment investment.

Average composition of total economy investments[1]
Average gross fixed capital formation as a share of gross value added[2]
%



1 Sorted by level of equipment investment in 2010–15.
2 Nominal values.
3 Includes computer software and databases, and research and development.
NOTE: Figures may not sum to 100% because of rounding.

SOURCE: EU KLEMS (2017 release); McKinsey Global Institute analysis

[35] Investment as measured by average gross fixed capital formation as a share of gross value added.

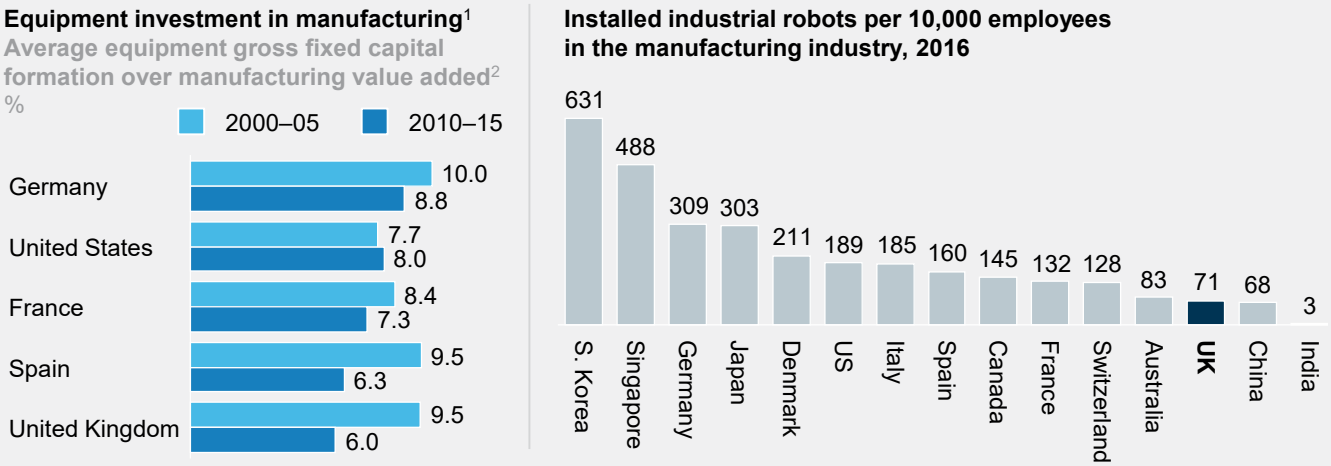
Box 4. How stronger hiring and weaker investment explain a productivity growth decline in manufacturing

Once an engine of productivity growth for the United Kingdom, the manufacturing sector experienced a substantial decline after the financial crisis that played an outsize role in the aggregate productivity growth slowdown. Manufacturing-sector employment grew while capital investment fell in the post-crisis period, mirroring trends in the UK economy at large. As a result, labour productivity in manufacturing grew only 0.1 percent per year in the 2010 to 2015 period, a substantial drop from the 4.7 percent average annual growth in the pre-crisis period. In manufacturing, a pre-crisis restructuring and outsourcing trend was replaced by robust post-crisis employment growth as firms employed flexible, relatively cheap labour to boost output rather than investing in capital. Before the crisis, hours worked declined by 5 percent a year across all manufacturing subsectors as manufacturers outsourced jobs to low-cost regions, restructured their workforces, and drove greater operational efficiency. This created significant productivity growth, not just in subsectors where value added was growing (for example, chemicals and chemical products), but even in subsectors where value added was declining (for example, textiles, apparel, leather, and related products). In sharp contrast, post-crisis hours worked increased 0.4 percent per year. Combined with modest growth in value added at 0.5 percent annually, productivity growth in the manufacturing sector declined to 0.1 percent a year in the period 2010 to 2015. This slowdown in manufacturing also helps to explain the TFP growth decline seen in the United Kingdom, of which a quarter came from the manufacturing sector. Within manufacturing, chemicals and chemical products and machinery and equipment were the largest contributors.[1] In the post-crisis period, increased uncertainty due to the financial crisis coupled with an increase in the availability of relatively low-cost, flexible labour discouraged manufacturers from investing in capital to drive output growth.

A further challenge to productivity growth in the manufacturing sector is that UK manufacturers have tended to be slow in adopting cutting-edge technologies. For example, today, the UK manufacturing sector has one of the lowest levels of robotic equipment in the world, lagging far behind European competitors such as Germany and France. Increasing robotics adoption would require significant investment, and yet equipment investment in manufacturing as a share of value added has fallen more in the United Kingdom than in any other country in our sample (Exhibit 12). According to research undertaken by EEF (originally the Engineering Employers' Federation) and Oracle, only 11 percent of manufacturers think the United Kingdom is ready to take advantage of the fourth Industrial Revolution, even though 80 percent believe it will be a reality for industry by 2025.[2]

Exhibit 12

The United Kingdom saw the largest decline in equipment investment in the manufacturing sector while having a low density of industrial robots.



1 Sorted by equipment investment over value-added in 2010–15.
2 Nominal values.

SOURCE: EU KLEMS (2017 release); International Federation of Robots; Statista; McKinsey Global Institute analysis

1 The decline in chemical products and chemicals includes a slowdown in productivity growth for the pharmaceuticals sector, where a "patent cliff" (the sharp decline in UK pharmaceutical revenues upon patent expiry) from 2011 onwards resulted in a shock to value-added growth.

2 *The 4th Industrial Revolution: A primer for manufacturers,* EEF and Oracle, 2016.

THE UNITED KINGDOM IS DIGITISING, BUT THERE ARE SIGNIFICANT GAPS IN ADOPTION AND THE BENEFITS ARE NOT YET MATERIALISING AT SCALE

While the United Kingdom ranks highly in terms of broad measures of digital adoption, we find there are gaps with significant implications for productivity growth. The country does well in internet access, basic digital skills, and the adoption of cloud computing but poorly in other areas, especially in the integration of information systems across the value chain, deep business process transformations, and the adoption of robotics.[36] Across countries, while we find significant opportunities to boost productivity growth from digitisation, we also find that it comes with adoption barriers, lags, and transition costs, and the benefits have not yet materialised at scale. This pattern is similar to that observed in the previous ICT boom which started in the mid-1970s; productivity growth accelerated only after around 20 years of significant investment.[37]

The United Kingdom ranks well against its peers overall in terms of digitisation, and there is significant upside potential yet to be captured

Digitisation is underway in the United Kingdom, which ranks among the top digitising nations.[38] According to MGI's digital ranking, the United Kingdom is operating at 17 percent of its digitisation potential, compared to 18 percent for the United States and 12 percent on average for Europe. The European Union's findings on digitisation are similar. At 35 percent, UK enterprises' adoption of cloud computing is the fifth highest in the EU, after Finland, Sweden, Denmark, and Ireland.[39] According to the European Commission's Digital Economy and Society Index, the United Kingdom ranks seventh in Europe, below Denmark, Sweden, Finland, the Netherlands, Luxembourg, and Ireland, and above peers such as Germany and France. In surveys of UK firms, we find that the majority, 52 percent, believe that digitisation will have a "moderate" to "very positive" impact on their business.[40]

Despite this optimism, the benefits of digitisation are not yet evident in UK productivity numbers. In part, this is because digitisation takes time and is not yet at scale. Some sectors like technology, media, and finance are more advanced in digitisation, while other sectors like healthcare, construction, and government lag behind. In retail, for example, we find online sales are twice as productive as offline but currently make up only 14 percent of total sales in the United Kingdom.[41] That outstrips peer countries, but significant potential exists to improve retail productivity through online channels. For example, when we spoke with an executive at a leading UK retailer, they noted that realising the productivity benefits of online retail requires retailers to transform their supply chain end-to-end, not just the front end. In finance, online banking penetration in the United Kingdom is around 68 percent.[42] This compares to Sweden, for example, with one of the highest online penetration rates at 86 percent.

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36 *UK Digital Strategy 2017,* Department for Digital, Culture, Media & Sport, March 2017. See also Exhibit 13 showing relatively high rates of internet access and lower use of use of next-generation technologies.

37 *Solving the productivity puzzle: The role of demand and the promise of digitization,* McKinsey Global Institute, February 2018.

38 *Digital Europe: Pushing the boundary, capturing the benefits,* McKinsey Global Institute, June 2016.

39 "Cloud computing: Statistics on the use by enterprises", Eurostat, December 2018.

40 2017 MGI Business Survey.

41 *Solving the productivity puzzle: The role of demand and the promise of digitization,* McKinsey Global Institute, February 2018.

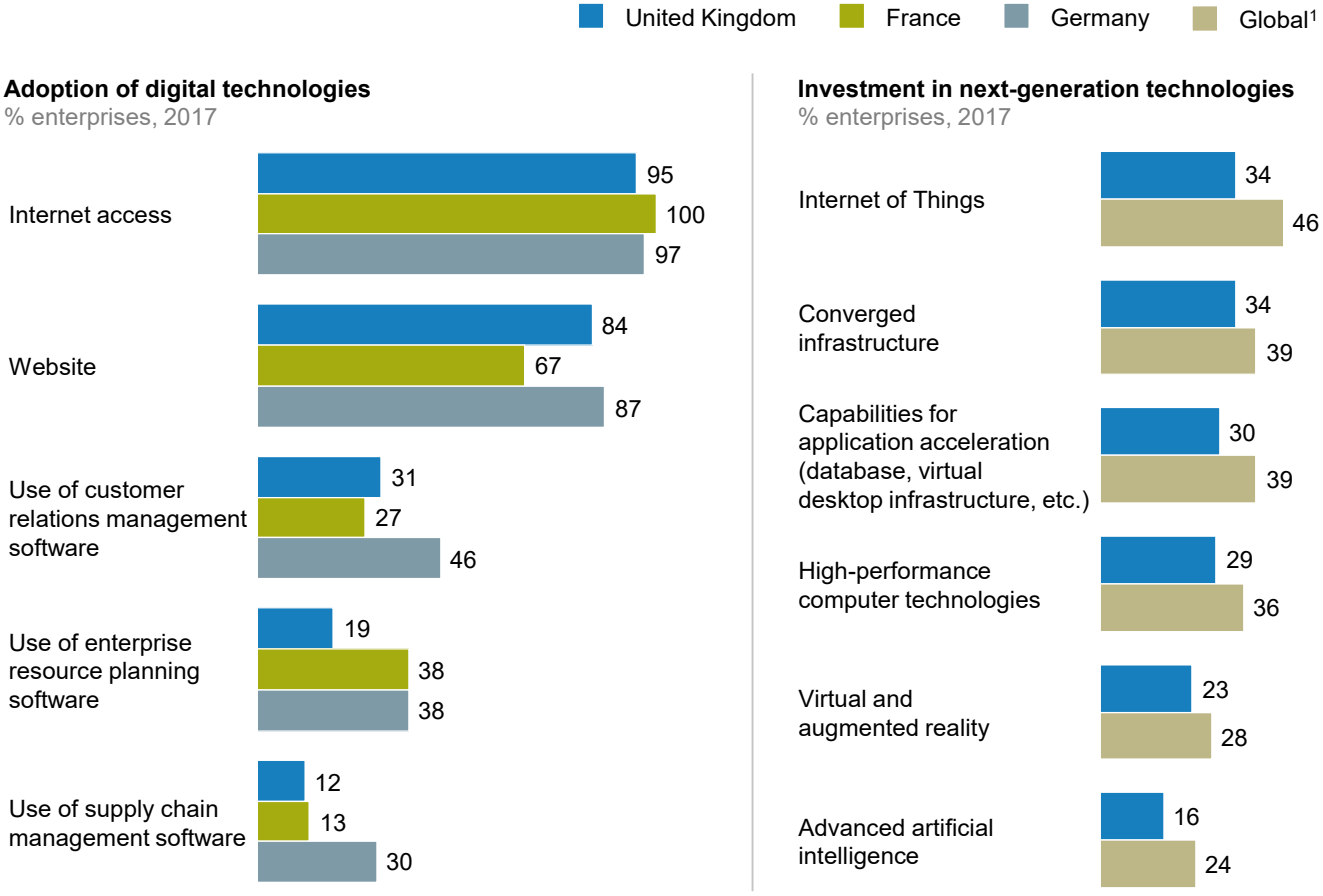
42 "Percentage of individuals aged 16 to 74 using the internet for internet banking", Eurostat, 2017.

Digitisation is happening unevenly in the UK, and the country lags in the adoption of some next-generation digital technologies

When we look beyond the United Kingdom's relatively strong headline performance on digitisation metrics, we find the country has been particularly good at digitising some parts of the value chain, but there are gaps in the digitisation of some core business processes, such as customer relationship management and supply chain management, and in investment in next-generation technologies like the Internet of Things and advanced artificial intelligence (Exhibit 13). These aspects of digitisation may be the most important ones to jump-start productivity, as they involve redesigning and transforming processes or entire businesses and are likely to result in significant labour savings for a given amount of output. As discussed above, the United Kingdom also lags behind in robotics adoption in manufacturing. Without this investment and the associated end-to-end standardisation, digitisation, and automation, productivity growth will not reach its full potential in that sector.

Exhibit 13

The United Kingdom has gaps in value chain integration of digital technologies and lags behind in terms of investment in several next-generation technologies.



1 Includes Australia, Brazil, China, France, Germany, India, Italy, Japan, Mexico, Netherlands, New Zealand, Saudi Arabia, Singapore, South Africa, United Arab Emirates, United Kingdom, and United States.

SOURCE: *UK Digital Strategy 2017*, Department for Digital, Culture, Media and Sports, March 2017; Eurostat; *Realizing 2030: A divided vision of the future*, Dell, 2018; "UK lags behind Europe in technology investment", *Digitalisation World*, March 2018; McKinsey Global Institute analysis

We also find a mixed picture concerning digital skills. The United Kingdom attracts tech talent from other countries, achieving a 26 percent surplus as measured by inflows minus outflows of tech founders.[43] According to the Digital Economy and Society Index, it ranks

[43] *The State of European Tech Report 2017,* Atomico, December 2017.

fourth in relevant human capital.[44] On the human capital dimension, 93 percent of the UK population uses the internet regularly (EU average: 81 percent), 71 percent of the population has basic digital skills (EU average: 57 percent), and 5.1 percent of the population are ICT specialists (EU average: 3.7 percent).[45] Yet this also means that 29 percent of the population does not have basic digital skills. Additionally, the fact that the United Kingdom has higher digital skills and more ICT specialists than other countries does not mean it has enough of either. In fact, according to the House of Commons, the country suffers from a digital skills shortage.[46] The percentage of job vacancies in the ICT sector is 3.2 percent, 14 percent higher than the average in the EU.[47] Finally, "lack of skills" is the second most important barrier to business investment in technology in the United Kingdom, and "lack of management and/or technical capability to execute investments" is the third most important reason that UK companies do not invest in all attractive opportunities.[48]

Digitisation takes time and comes with adoption barriers, lags, and transition costs

History shows that technological diffusion takes time and comes with barriers to adoption.[49] An MGI review of the historical rate of adoption of 25 previous technologies over the past half century shows that the time from commercial availability to 90 percent adoption ranges from approximately eight to 28 years.[50] In the 1970s and 80s, this became known as the "Solow Paradox" after the economist Robert Solow, who noted that the information age is everywhere, except in the productivity numbers. At that time, productivity growth in the United States slowed despite innovations in the area of microelectronics and communications technology.[51] Productivity gains were not automatic and did not occur in all industries that invested heavily in ICT. Instead, real productivity gains required significant changes in business processes, as well as managerial and technical innovation.[52]

The challenge of adoption may be even harder this time around because of the broad range of uses of digital that not only help improve current processes but fundamentally transform business models and operations (see Box 5, "Electronic shelf labels in retail provide a window into the transition to digital"). For example, in retail, the first ICT revolution was focused on getting the right goods to the right place at the right time. With digitisation, the transition to online requires building a new channel with a new supply chain structure to

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44 *Digital Economy and Society Index (DESI),* European Commission, 2018.

45 DESI; "Employed ICT specialists as a percentage of total employment", Eurostat.

46 *Digital skills crisis,* House of Commons, 2016.

47 Based on data from Eurostat. The percentage of job vacancies is calculated as the number of job vacancies over the sum of job vacancies and occupied posts. A job vacancy is defined as a paid post that is newly created, unoccupied, or about to become vacant, for which the employer is taking active steps and is prepared to take further steps to find a suitable candidate from outside the enterprise concerned, and which the employer intends to fill either immediately or within a specific period of time.

48 See *Embracing digital in every sector,* Confederation of British Industry, 2016, and McKinsey Global Surveys, McKinsey & Company, 2017. From March 6 to March 10, 2017, we surveyed 1,570 global participants on investment opportunities. The respondents represented the full range of regions, industries, company sizes, functional specialties, and tenures. Of them, 102 were based in the United Kingdom.

49 Boyan Jovanovic and Peter L. Rousseau, "General purpose technologies", in *Handbook of Economic Growth,* Volume 1B, Philippe Aghion and Steven Durlauf, eds., Amsterdam, Netherlands: Elsevier, 2005. Take the advent of steam power, for example. Productivity growth was quite rapid, at 2 to 3 percent a year, when steam power was introduced around 1870 but fell with the arrival of electrification in the 1890s, to 1 to 2 percent a year in the United States. It was only in the period after 1915, which saw the diffusion of machines operated by stand-alone secondary motors and the widespread establishment of centralised power grids, that electricity finally pervaded businesses and households, and productivity growth began to rise, to 3 percent a year. See also Paul David, *Computer and dynamo: The modern productivity paradox in a not-too distant mirror,* The Warwick Economics Research Paper Series, 1989.

50 *A future that works: Automation, employment, and productivity,* McKinsey Global Institute, January 2017. See also Diego Comin and Bart Hobijn, "An exploration of technology diffusion", *American Economic Review,* December 2010, Volume 100, Number 5.

51 Paul David, *Computer and dynamo: The modern productivity paradox in a not-too distant mirror,* The Warwick Economics Research Paper Series, 1989.

52 *How IT enables productivity growth: The US experience across three sectors in the 1990s,* McKinsey Global Institute, November 2002.

deliver goods directly to customers and determining what combination of stores and online presence is optimal. Our survey also shows fear of technological obsolescence as a key barrier. Finally, some incumbents have reasons to actively delay adoption, whether for fear of cannibalization or, in some cases, the challenges of large-scale transformations.

In a recent survey we conducted, companies with digital transformations underway said that 17 percent of their market share from core products or services was cannibalized by their own digital products or services.[53] Productivity growth may also drag because incumbents have to maintain duplicate structures and processes across online and traditional operations. For example, online penetration in the banking industry in the United Kingdom was 68 percent in 2017, up from 27 percent in 2005.[54] Yet the number of branches per 100,000 inhabitants has stayed constant at around 25.[55] In our interviews with firms, one executive at a UK bank said that while many digital innovations so far have offered improved customer experience, they have not necessarily lifted the productivity of banks yet. Productivity benefits across sectors are therefore likely to materialise only as traditional operations are restructured or closed and adoption costs are outweighed by benefits as digitisation reaches scale.

Finally, embracing the next generation of digital and automated technology will require investment, risk-taking, and experimentation. In this context, ongoing uncertainty could slow down the United Kingdom's technology transformation. In our surveys of UK businesses, "risk aversion" is the main factor mentioned when respondents are asked why they do not commit to attractive investment opportunities.[56] To capitalise on the digital opportunity, the country will need to create economic stability and opportunities for sometimes risky, but productive, investments.

[53] *McKinsey Digital Global Survey 2017: How digital reinventors are pulling away from the pack,* McKinsey & Company, October 2017.

[54] "Penetration of online internet banking among individuals aged 16–17", Eurostat.

[55] Commercial bank branches (per 100,000 adults), World Bank.

[56] McKinsey Global Surveys, McKinsey & Company, 2017.

Box 5. Electronic shelf labels in retail provide a window into digital transition issues

Although digitisation at scale offers the promise of improved productivity, the case for investing is not always clear-cut, and the greatest promise typically lies in end-to-end digitisation rather than small tweaks. Take, for example, the use of electronic shelf labelling in the retail sector. While it is common in French and German grocery chains, it is not in the United Kingdom, which relies on paper tags manually updated by workers.

Electronic shelf labelling offers the promise of reduced labour costs because the labels are automatically updated. We spoke with a representative of a leading UK retailer that considered this investment in 2010 and has considered it several times since then. The retailer found that it was difficult to make the economics of electronic shelf labelling work in the United Kingdom. At current labour costs and the price of £30 per electronic tag, the investment pays for itself only when there are more than 60 price changes per year for a given line.[1] Given that 50 to 60 percent of lines will require a price update only once a year, the executive we interviewed considered that the investment was not worthwhile at this stage.

As with many digital products, it is possible to make electronic shelf labelling work, but it requires retailers to embrace end-to-end digitisation and not just view digital technologies as cost-reduction tools. This would involve a fundamental rethinking of digital by most retailers to broaden the scope and strategy of digitisation to include, for example:

- **Dynamic pricing.** UK retailers set national prices and maintain the same prices for goods throughout the day, whereas German and French retailers tend to change prices more frequently, for example to anticipate demand for an item in the evening. Online retailers such as Amazon use artificial intelligence to review pricing continually, changing millions of prices a day.[2] Dynamic pricing would create opportunities to better manage food that was close to its expiry date and to respond to customer demand.
- **Improved customer experience.** Other than showing the price of an item, electronic shelf labelling has limited customer experience benefits. More upside beyond labour cost savings could be created by enabling increased customer interaction with technology, for example through touch-sensitive screens or through interaction with apps on users' phones.
- **Additional revenue opportunities.** The next generation of electronic pricing uses digital shelves rather than digital labels and includes the ability to feature advertising displays as well as pricing.
- **Value chain digitisation.** There are more cost savings to be made in digitising the value chain, for example by integrating shelf pricing with expiry dates and supply chain data to optimise the sourcing of food.

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1 Assumes the hourly cost of labour in the retail sector is £20 and that a worker can manually change 120 price tags in an hour. At £30 per unit for a single electronic shelf label and a three-year shelf life per label, prices for a single unit would need to change 60 times per year for the up-front investment for an electronic shelf label to break even.

2 *Amazon makes more than 2.5 million daily price changes,* Profitero Price Intelligence, December 2013.

3. STEPS TO ACCELERATE UK PRODUCTIVITY GROWTH

Productivity in the years to come will be more important for the United Kingdom's future economic growth and living standards than ever before. Labour supply is unlikely to expand indefinitely, and demographic shifts, specifically an aging population, mean that about 90 percent of future growth will need to come from productivity to keep pace with historical GDP growth rates.[57] Based on our analysis above of the causes of the productivity growth slowdown, the United Kingdom has an opportunity to boost productivity growth by focussing on education and skills (to make the most of the high workforce participation in the United Kingdom), further accelerating the adoption of digital technologies (to capture their full potential), and supporting investment and exports to build broad-based resilience for the future (to mitigate against boom/bust cycles and uncertainty).

THE UNITED KINGDOM COULD ACCELERATE PRODUCTIVITY GROWTH TO 2 PERCENT BUT THIS WILL REQUIRE CONCERTED ACTION BY BUSINESS AND GOVERNMENT

Looking ahead, continued jobs growth, coupled with changes in net migration, are resulting in a tighter labour market, making productivity growth even more important for economic growth and prosperity. This is likely to be further exacerbated by the impact of an aging population on labour supply. The financial sector, a strong engine of productivity growth pre-crisis, is unlikely to deliver similarly high growth rates sustainably in the future. Moreover, uncertainty and transition costs due to Brexit and other geopolitical developments may dampen investment and growth.

However, we believe that improvements in workforce skills and the economy-wide adoption of digital technologies could compensate, and that promoting investment and exports can mitigate future boom and bust cycles, risks, and uncertainty. In MGI's productivity research covering advanced economies, we calculated that digitisation could add one percentage point or more to annual productivity growth over the next decade.[58] Broad digital adoption would require enhanced management skills and better skill systems, which in turn could further boost productivity growth. Many automation technologies are also being enhanced with ever-increasing volumes of more complex data and the use of artificial intelligence to further raise efficiency.

For example, in the industrial sector, predictive maintenance through machine learning software and the Internet of Things, with remote sensors on robots to identify the likelihood of failures, can boost asset productivity by up to 20 percent.[59] In finance, the automation of knowledge work could be significant for productivity, as automatable activities like operation of branch networks, operation of call centres, and production and distribution of monthly paper statements typically represent between 40 and 60 percent of total costs in retail and commercial banking.[60] We found that digital and nondigital opportunities together created the potential for advanced economies' productivity growth to accelerate to 2 percent or more a year over the next decade. Achieving this potential is by no means guaranteed, though. This has always been the case with productivity opportunities; however, making the most of this wave of productivity opportunities may require tackling additional barriers to growth. The digital transformation underway, for example, comes with adoption barriers, lags and transition costs, and could also be associated with a skills mismatch, particularly

[57] *Global growth: Can productivity save the day in an aging world?* McKinsey Global Institute, January 2015.

[58] *Solving the productivity puzzle: The role of demand and the promise of digitization,* McKinsey Global Institute, February 2018.

[59] *Smartening up with Artificial Intelligence (AI) - What's in it for Germany and its Industrial Sector?* Digital McKinsey, April 2017.

[60] *A brave new world for global banking: McKinsey global banking annual review 2016,* McKinsey & Company, January 2017.

for high skilled workers.[61] Drags on demand and consumption, for example from changing demographics and rising income inequality, could also impact productivity growth through lowering investment, reducing economies of scale, and shifting consumption to lower-value goods and services.[62] Thus capturing this productivity opportunity will require a combination of policy action and action on the part of companies. In what follows, we highlight key priorities for action.

STEPS TO GROW PRODUCTIVITY INCLUDE PROMOTING WORKFORCE SKILLS, DIGITAL ADOPTION, AND INVESTMENT AND EXPORTS

Supportive government policies and action by businesses can help the United Kingdom reach its productivity potential. Based on the reasons for the productivity growth slowdown outlined above, we identify three critical areas the country can focus on today that could result in higher productivity growth. First and foremost, improving education and skills would help turn a low-productivity employment puzzle into a high-productivity and high-employment growth trajectory while also supporting a digital transformation. Secondly, closing adoption gaps in digital and next-generation technologies could boost productivity growth but will require better information, access to finance, collaborations, and a favourable policy environment for diffusion. Lastly, policy makers can mitigate boom and bust cycles as well as uncertainty from Brexit and broader geopolitical developments by actively promoting investment and exports.

To be sure, designing policies in these areas is challenging, and successful productivity-boosting initiatives require careful thought, research, experimentation—and persistent execution. For example, it is well understood that enhancing employees' skills is critical for driving productivity growth and maintaining high levels of employment in an era of rapid technological change. Yet what is less clear is the most effective way to achieve that. What kind of education system better equips young people for the workplace of the future? When retraining workers, are government or private-sector programmes more effective? How can reskilling and upskilling be delivered affordably and at scale? How can firms overcome change resistance and inertia in adopting new practices and technologies? While detailed answers to these questions are beyond the scope of this discussion paper, below we provide examples of policies that have worked in the United Kingdom and other countries and that merit further consideration in the quest to accelerate UK productivity growth.

Invest in skills development for existing and future workers and facilitate reskilling while also developing critical management skills

While the employment puzzle described above has had the positive effect of high levels of workforce participation, it also means that the United Kingdom has become increasingly dependent on labour to drive output growth. Like other nations, it will also need to respond to the digital transformations taking place in global markets and the rapidly changing competition that comes with them. This makes getting the most out of the country's human capital and equipping it with the skills of tomorrow an even more important task. To do this, the United Kingdom needs to build an education system that meets the needs of a fast-changing digital economy, upgrade the skills of its existing workforce at scale, and ensure that businesses have the managerial skill set to productively lead that workforce and support digital transformations.

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[61] See *Notes from the frontier: Modeling the impact of AI on the world economy*, McKinsey Global Institute, September 2018; *Skill shift: Automation and the future of the workforce*, McKinsey Global Institute, May 2018; *Getting skills right; skills for jobs indicators*, OECD, July 2017.

[62] See *Solving the productivity puzzle, McKinsey Global Institute*, February 2018, for more details.

Diffuse good practices and technology adoption by investing in the training of managers across firms and industries

Historically, UK firms have performed worse on measures of good business practices, such as lean operations, performance monitoring, and aspects of talent management, than firms in Germany and the United States. UK firms also score lower on McKinsey's Organisational Health Index than the global median.[63] This has implications for productivity. For instance, management performance scores indicate that UK businesses in the top decile are 2.9 times more productive than businesses in the bottom decile.[64] Aside from productivity, moving a business from the bottom to the top decile of management practices is associated with $15 million more in profits, 25 percent faster annual growth, and ten times more investment in R&D.[65] Given the unprecedented increase in employment after the financial crisis, management skills are now even more important as firms seek to make the most of their workforce. Moreover, poor management practices make it less likely that a firm will invest in and adopt ICT and digital technology effectively.[66]

Policy makers can help in a number of ways. The UK government has already recognized the importance of management practices by launching the Business Productivity Review and by backing Be the Business, a national movement to improve performance and highlight best practice advice and experiences.[67] The evidence on "what works" to boost managerial practices is limited, especially in the case of the nearly 80 percent of UK small and medium-size enterprises (SMEs) that believe their business is as productive as or more productive than their peers.[68] However, the wide range of experiments, pilots, and programmes being tested by Be the Business and its partners is encouraging. These include an online tool for businesses to benchmark their practices and receive actionable advice, a mentorship programme between highly productive and less productive firms, and a training programme for managers to learn and implement best practice methods in their businesses.

Experiences in other countries, such as Canada, Denmark, India, and Mexico, show that active advice and coaching of business leaders can be effective in boosting sales, employment, and productivity.[69] However, the most proven methods for enhancing managerial skills and practices tend to involve relatively intense, often face-to-face and on-the-job support, such as a "field and forum" approach that combines classroom-based instruction with experiential learning.[70] The same is likely to be true for enhancing management's capacity to adopt and implement new technologies, from building the initial business case to delivering the business process changes required to make the most of new systems. This suggests that the big questions for the United Kingdom's productivity challenge will be how to deliver such programmes at scale and how to overcome management's biggest barrier to improvement, a lack of time.[71]

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63 McKinsey OHI database, 2017; *From ostrich to magpie: Increasing business take-up of proven ideas and technologies,* Confederation of British Industry, November 2017.

64 *Management practice and productivity in British production and services industries: Initial results from the Management and Expectations Survey 2016,* Office for National Statistics, 2018.

65 Nicholas Bloom, Raffaella Sedun, and John Van Reenen, "Why do we undervalue competent management?" *Harvard Business Review,* September-October 2017.

66 *From ostrich to magpie: Increasing business take-up of proven ideas and technologies,* Confederation of British Industry, November 2017.

67 *Industrial strategy: Building a Britain fit for the future,* HM Government, November 2017; *Business productivity review: Government call for evidence,* Department for Business, Energy and Industrial Strategy, May 2018.

68 *Overconfidence on productivity is hampering British performance,* Be the Business, May 2018.

69 *Business productivity review: Government call for evidence,* Department for Business, Energy and Industrial Strategy, May 2018.

70 Elena Dumitrescu, Erhard Feige, Cinzia Lacopeta, and Amy Radermacher, *To make a transformation succeed, invest in capability building,* McKinsey & Company, October 2017; David McKenzie and Chris Woodruff, "Business practices in small firms in developing countries", *Management Science,* 2017, Volume 63, Issue 9, pp. 2967–81.

71 *From ostrich to magpie: Increasing business take-up of proven ideas and technologies,* Confederation of British Industry, November 2017.

Boost the skills of the current workforce and prepare for future skill shifts

MGI estimates that over 30 percent of workers in developed economies will need to switch occupational categories in order to remain employed by 2030.[72] The lion's share—roughly 76 percent—of the United Kingdom's 2030 workforce has already entered the workforce.[73] This points to the central importance of retraining and skill-building programmes for existing workers. Based on our analysis, these programmes will have a dual function in the United Kingdom: improving foundational skills, especially for workers with low levels of literacy, numeracy, and problem-solving capability, as well as building the skills for workers to succeed in a digitised and automated economy. As with managerial skills, delivering such improvements at the scale necessary is likely to be a significant challenge.

An example to consider is Denmark's flexicurity model, which brings together trade unions, the government, and businesses to maintain a flexible labour market while also supporting workers in finding new employment opportunities.[74] Two core components of the model are an active labour market policy that provides incentives for continuous learning and retraining, and a generous social welfare programme that helps unemployed workers retrain while they look for a new job. According to the Danish government, the country spends an estimated 1.5 percent of its GDP on offering guidance, a job, or education to the unemployed, compared to, for example, 0.2 percent of GDP spent in the United Kingdom on Jobseeker's Allowance on average between 2010–11 and 2015–16.[75] The Danish model aims to ensure that workers are prepared to meet the challenges posed by digitisation and automation.

UK policy makers could further work with business to identify future skills demand and consider funding and financing for workers or employers to retrain and reskill continually. Recent MGI research identified key skill shifts affecting the UK economy by 2030. For example, as a result of the country's predominantly knowledge-based economy, social and emotional skills—directing, supervising, managing, and coordinating—will overtake physical and manual skills as the largest skill group, rising from 21 percent of working hours in 2016 to 26 percent by 2030.[76] Higher cognitive skills and technological skills will also continue to grow in importance. To meet these skill shifts, the United Kingdom could adopt lessons from other countries that are already responding to changing skill requirements. For example, the Singapore government launched the SkillsFuture initiative in 2014 to enable lifelong learning and to contribute to creating a highly skilled and competitive workforce that is prepared for the future of work.[77] SkillsFuture works with industry associations and government bodies to identify future skill requirements and provides career guidance and high-quality training to support workers in continually developing and mastering new skills throughout their careers. Between 2015 and 2020, SkillsFuture expects to invest around $750 million a year in the programme, which will include a $375 credit to all of Singapore's 3.4 million citizens over the age of 25.[78]

However, the corporate sector also has an important role to play. A few examples demonstrate the potential approaches. Both AT&T and SAP are facing increasing pressures

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[72] *Jobs lost, jobs gained: Workforce transitions in a time of automation,* McKinsey Global Institute, November 2017.

[73] Calculated as the share of the current working age population (16- to 64-year-olds) who will still be in the working population in 2030 based on 2015-based population projections from Eurostat.

[74] *Realising human potential in the fourth Industrial Revolution: An agenda for leaders to shape the future of education, gender, and work,* World Economic Forum, January 2017.

[75] "Flexicurity", The Official Website of Denmark, 2017 (denmark.dk/en/society/welfare/flexicurity/); *Welfare spending: Jobseeker's allowance,* Office for Budget Responsibility, May 2018.

[76] *Skill shift: Automation and the future of the workforce,* McKinsey Global Institute, May 2018.

[77] *Realising human potential in the fourth Industrial Revolution: An agenda for leaders to shape the future of education, gender, and work,* World Economic Forum, January 2017; "About SkillsFuture", SkillsFuture, 2017, (www.skillsfuture.sg/AboutSkillsFuture).

[78] 500 Singaporean dollars. "Population trends 2017", Department of Statistics, Singapore, 2017; "Annex A-2: Summary of SkillsFuture initiatives: Singapore budget 2018", Ministry of Finance, February 2018.

to transform their existing business models in response to rapid changes in their industries. As part of the shift towards becoming a software-defined, mobile-first network, AT&T launched an ambitious training programme to reskill its nearly 280,000 employees globally, many of whom were trained in a different era for a cables and hardware industry that is now becoming obsolete.[79] The reskilling programme mapped the skills the company would require in the future, radically simplified internal role profiles, established an online portal that covers job vacancies and the skills required for each role, and partnered with external providers to help employees to develop these skills.[80] Since launching the programme in 2013, AT&T has spent $250 million on training and tuition aid for its employees and, as of March 2018, more than half of its employees have completed 2.7 million online courses in new digital skills. Retrained employees are two times more likely to be hired into newer, mission-critical jobs and four times more likely to succeed in career advancement than those who have not engaged in retraining.[81]

Like AT&T, SAP began by mapping the future skills the company will require as it responds to the pressures of Industry 4.0 and disrupts its existing products to offer more advanced solutions, including public cloud and machine learning–enabled services.[82] In order to support employees in transitioning to new roles, the company developed end-to-end learning journeys incorporating classroom learning, on-the-job practice in the new roles, and coaching. Both AT&T and SAP are seeing substantial numbers of employees changing their roles or activities. Companies of all sizes should consider the benefits that training and upskilling can bring, especially in enhancing their agility to meet future competitive pressures. A recent McKinsey survey found that agile business units are 1.5 times more likely than others to report financial outperformance relative to peers, and 1.7 times more likely to report outperforming their peers on nonfinancial measures.[83]

Modernize the education system to elevate the skills of the next generation

No effort to build skills is complete without rethinking the United Kingdom's current education system and raising the basic capabilities of school leavers, while also preparing future workers for jobs that do not yet exist. While ongoing reform efforts in UK education are underway, further work is required to ensure a system fit for the future.

Basic skills, particularly literacy, numeracy, and problem solving, remain the foundation for building a productive workforce, and this is an area where the United Kingdom remains behind comparable countries. A country that has made significant strides in this regard is Poland, which has overtaken the United Kingdom in international rankings on educational outcomes. Between 2000 and 2015, Poland's PISA scores in mathematics and reading increased by 34 points and 27 points, respectively, while the United Kingdom's scores fell 37 and 25 points. Two reform programmes drove these improvements in educational outcomes. The first, launched in 1999, added an additional year of schooling for 50 percent of students, empowered principals to select and retrain their teaching staff, and gave teachers greater choice over selecting curricula. The second, launched in 2008, broadened the curriculum and introduced a new evaluation system that strengthened professional development for teachers.[84]

The United Kingdom should also consider how to shape the education system so that it develops skills that will be critical for the future. Globally, up to 65 percent of primary

[79] John Donovan and Cathy Benko, "AT&T's talent overhaul", *Harvard Business Review,* October 2016.

[80] *Skill shift: Automation and the future of the workforce,* McKinsey Global Institute, May 2018.

[81] Susan Caminiti, "AT&T's $1 billion gamble: Retraining half its workforce for jobs of the future", CNBC, March 13, 2018.

[82] *Skill shift: Automation and the future of the workforce,* McKinsey Global Institute, May 2018.

[83] *How to create an agile organization,* McKinsey & Company, October 2017.

[84] Programme for International Student Assessment, Organisation for Economic Cooperation and Development, 2018; *Government productivity: Unlocking the $3.5 trillion opportunity,* McKinsey Center for Government, April 2017.

school students may work in jobs that do not yet exist.[85] As a result, education systems will need to adapt to reflect the changing dynamics of the workforce and support students in developing skills that are harder to automate, such as leadership, coaching, creativity, higher cognitive skills, and advanced digital skills, which will become even more important by 2030.[86] The Finnish education model provides an example of how to achieve this. The government regularly updates the national curriculum, yet allows local areas to customise their approach, de-emphasises the importance of testing and selection, and maintains high standards for teaching as an elite profession.[87] The most recent reforms aim to prepare students for the digital age through project- or phenomenon-based learning, which includes using technology more innovatively, structured around topics that are current and interesting to students, such as immigration.[88]

In addition, the United Kingdom could implement more digital skill training, including in its apprenticeship system. Every young person will need digital skills, and the government has already prioritised the development of high-quality apprenticeship programmes, but further lessons could be learned from other countries. For example, the Estonian government has a long history of driving initiatives aimed at creating a highly digitised society, starting in 1997 with the Tiger Leap Foundation, which connected all Estonian schools to the internet and funded ICT training for teachers.[89] The ProgeTiger programme, launched in 2012, initially aimed to teach programming and robotics in preschool, primary, and vocational education. It has now broadened to develop a wider range of IT skills needed for the future by integrating modern technologies directly into the teaching of a wide range of school subjects and extracurricular activities.[90]

Applying a gender lens to skills programmes across the board—both for existing and future workers and managers—will also be important. Today, women in the United Kingdom work in less productive sectors and are concentrated in lower-paid occupations, which affects their financial stability and purchasing power.[91] They are least represented in high-productivity areas—including science, technology, engineering, and math (STEM)—and higher-salaried occupations, including skilled trades and managerial and leadership positions. The United Kingdom is facing a STEM skills gap, with an additional one million new professionals needed by 2020. This talent shortage could impede the progress of the United Kingdom's most productive industries, such as energy and manufacturing. While some STEM careers such as healthcare employ many women, in other careers, such as engineering, women make up only 10 percent of the workforce. Paving the way for women to occupy these types of roles could support productivity gains and act as one of the levers for the United Kingdom to narrow the productivity gap with its peers.

Accelerate digital adoption through information sharing, access to finance, greater collaboration, and a favourable policy environment for diffusion

Compared to other European countries, the United Kingdom ranks well in overall digitisation, but there are gaps in making the most of the latest generation of technologies, such as those related to Industry 4.0, and modernising entire processes and businesses.

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85 *Renew Europe,* World Economic Forum, January 2018.

86 *Skill shift: Automation and the future of the workforce,* McKinsey Global Institute, May 2018.

87 *Realising human potential in the fourth Industrial Revolution: An agenda for leaders to shape the future of education, gender, and work,* World Economic Forum, January 2017.

88 Penny Spiller, "Could subjects soon be a thing of the past in Finland?" BBC News, May 29, 2017.

89 "Factsheet: e-Education", e-Estonia, 2018.

90 *Estonian lifelong learning strategy 2020,* Republic of Estonia Ministry of Education and Research, 2014; *ProgeTiger Programme,* HITSA, Information Technology Foundation for Education, 2018 (www.hitsa.ee/it-education/educational-programmes/progetiger); *16 outstanding projects in the European Digital Skills Award 2016 final,* European Commission, 2016 (ec.europa.eu/digital-single-market/en/news/16-outstanding-projects-european-digital-skills-award-2016-final).

91 For further details, see *The power of parity: Advancing women's equality in the United Kingdom,* McKinsey Global Institute, September 2016.

Furthermore, driving adoption is critical not just for productivity but also for the United Kingdom's future competitiveness, as digitisation and automation are changing the nature of competition between firms. Recent McKinsey research found that three-year revenue growth for the most proactive digital movers was over 12 percent, nearly twice that of companies playing it safe.[92] Implementing the recommendations of the Made Smarter Review should help address these issues in the manufacturing sector, but to see higher rates of productivity growth at the aggregate level, similar initiatives are required across the economy.[93] Recently, the UK government announced the launch of the Business Basics Fund to support small businesses in adopting new technologies, management practices, and business support services to boost performance and productivity.[94] Larger and more global companies also have a critical role to play. Not only do they have an important effect on overall productivity growth but they also have a broader influence by driving adoption of digital technologies and productivity-enhancing practices in their supply chains.

A lack of awareness of new technologies and how best to use them, particularly among SMEs, has been identified as a key barrier to adoption in the United Kingdom.[95] One initiative to address this could be to develop a single online platform that collates information on digitisation and automation for UK businesses, by sector and function, covering information on use cases, available support, networking events, and best practice sharing. The platform could also provide user-generated reviews of technology providers, as well as consultancies or other support for technology adoption. Such information provision could significantly reduce the search costs for businesses in accessing the help they need.[96] In addition, businesses may benefit from more hands-on guidance to implement end-to-end digital transformations and to capitalise on the productivity opportunity. For example, Denmark's Advanced Technology Group, or GTS—similar to the United Kingdom's Catapult network—aims to drive innovation in Danish industry by sharing new and existing knowledge and technical know-how with companies and public institutions. Its services include courses, consultancy, certification, and "innovation checks" to assess SMEs' innovation potential.[97]

Firms may also need enhanced incentives and access to finance to adopt what may seem risky new assets and technologies, especially since these are often fully integrated into operations and therefore require corresponding changes to staff and business processes. There is evidence, for example, that even in the United States, where capital markets are relatively fluid, banks are more reluctant to lend money to support investment in intangible capital, including the adoption of technology.[98] Existing financial instruments may need to be reviewed, refined, or replaced to help businesses invest in digital and automation technologies. For example, the German government's Digitisation and Innovation Loan provides businesses, even firms with weaker credit ratings, with funding to invest in new technologies.[99]

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92 Jacques Bughin, Tanguy Catlin, Martin Hirt, and Paul Willmott, "Why digital strategies fail", *McKinsey Quarterly,* January 2018.

93 *Made Smarter Review 2017,* Department for Business, Energy, and Industrial Strategy, October 2017. The industry-backed report aims to improve growth and productivity in the manufacturing sector through unlocking the benefits of digital technologies, with the aim of making the UK a leader in the fourth Industrial Revolution.

94 *Government launches new fund to support small businesses' earning power,* Department for Business, Energy, and Industrial Strategy, June 2018.

95 *Ibid.*

96 *From ostrich to magpie: Increasing business take-up of proven ideas and technologies,* Confederation of British Industry, November 2017.

97 "About GTS", GTS, Advanced Technology Group (en.gts-net.dk/).

98 Andrea Caggese and Ander Pérez-Orive, *Capital misallocation and secular stagnation,* Finance and Economics Discussion Series number 2017-009. Federal Reserve Board, 2017.

99 *KfW extends innovation funding to projects focusing on digitisation,* Federal Ministry for Economic Affairs and Energy, May 5, 2017.

Yet another initiative might be to develop a partnership programme linking academia, other research institutions, IT companies, disruptive startups, scale-ups, and entrepreneurs with existing businesses to codevelop digital solutions to problems faced by companies. Australia provides an interesting example of a relevant initiative: Slingshot, a corporate startup accelerator, delivers programmes that connect established corporations with disruptive startups. Corporations bring scale, resources, and access to markets while startups bring the agility and innovation to drive commercial outcomes.[100] For the United Kingdom, a fruitful area in which to explore such collaborations could be artificial intelligence. MGI's recent research suggests that adoption of AI by businesses was correlated with a strong presence of local innovators delivering AI solutions.[101] While the United States and China dominate the AI landscape, the strongest AI ecosystem in Europe is currently in and around London. The United Kingdom also leads Europe on overall AI adoption: 26 percent of UK companies surveyed by MGI had adopted at least one AI technology at scale, compared to 20 percent in France and 12 percent in Germany.[102]

Finally, as noted in MGI's productivity research covering advanced economies, governments have many other tools to ensure that they create a favourable policy environment for digital diffusion. These include: leading by example on digitisation, leveraging public procurement and investment in R&D, ensuring global connectivity, promoting standardisation in areas such as the Internet of Things, investing in cybersecurity, and clarifying regulations on artificial intelligence, data privacy, and data ownership.[103] For example, even though the United Kingdom's digital infrastructure is generally good by international standards, continuing to upgrade it is important in order to take advantage of the next wave of digital technology.[104]

Promote investment and exports to shore up economic resilience for the future

Even with enhanced workforce skills and widespread technology adoption, the United Kingdom's productivity growth could be jeopardized by further boom and bust cycles or waning capital stock. This is particularly the case in the face of risks and uncertainties relating to Brexit and the broader geopolitical climate. In this context, policies that support broad-based growth and resilience—across all sectors and regions—should be a priority. Previous work has highlighted two key areas for policy makers to focus on: investment to relieve infrastructure bottlenecks and targeted support to grow exports.

In our estimate, the UK has had significant infrastructure investment gaps for a long time, and despite significant increases in transport investment over the past half decade, overall public and private infrastructure investment as a share of GDP rose above pre-crisis levels only in 2017.[105] This is despite such investments often representing high value for money, especially if they relieve existing bottlenecks and generate agglomeration benefits. Improving connectivity between large cities and reducing congestion within cities in the United Kingdom has been identified as a priority to drive regional productivity growth. As an illustration, lowering travel times from Leeds to Manchester and Sheffield to 30 minutes could lift productivity in the city by more than 10 percent.[106]

Another important area of infrastructure is housing, where investment collapsed following the 2008 crisis. Our research shows that London has one of the highest housing affordability

[100] For more information, see Slingshot (www.slingshotters.com).

[101] *Artificial intelligence: The next digital frontier?* McKinsey Global Institute, June 2017.

[102] *Ibid.*

[103] *Solving the productivity puzzle: The role of demand and the promise of digitization,* McKinsey Global Institute, February 2018.

[104] *Unlocking regional growth: Understanding the drivers of productivity across the UK's regions and nations,* Confederation of British Industry, December 2016.

[105] *Bridging infrastructure gaps: Has the world made progress?* McKinsey Global Institute, October 2017.

[106] *Unlocking regional growth: Understanding the drivers of productivity across the UK's regions and nations,* Confederation of British Industry, December 2016.

gaps in Europe at around 2 percent of city GDP, with over a third of metropolitan households unable to afford decent places to stay at market rates.[107] While housing completions are up 50 percent since the post-crisis trough of 2010, they have not materially exceeded pre-crisis peaks and are only 35 percent higher than 1990, despite a sixfold price increase since then.[108] The current completion rate of around 20,000 homes per year in London falls short of new estimates that 66,000 homes a year are required to meet demand for housing in the capital.[109] Our past research has identified various approaches to tackling the affordable housing gap, all of which also apply to the United Kingdom. These include unlocking land supply, reducing construction costs, improving operations and maintenance, and lowering financing costs.[110]

A recurring theme, also further emphasised by Brexit, is the importance of encouraging exports to help drive broad-based productivity growth. In the United Kingdom, export activity is concentrated in a small number of firms: of a total of 5.5 million private-sector businesses at the beginning of 2016, only around 200,000 were exporters.[111] In 2013, the top 100 exporters accounted for 50 per cent of export value, compared to Germany where the corresponding figure was 38 percent.[112] Yet exporting is important for productivity. While more productive firms are more likely to be competitive in export markets, it has also been shown that becoming an exporter makes a company more productive as it becomes exposed to more competition, more demanding customers, and new ideas.[113] Research has found that between 10 and 15 percent of UK firms, across all regions, are latent exporters.[114] This means they share the characteristics of exporting companies but are not currently exporting. Identifying and actively supporting these firms to start exporting could further boost the country's productivity growth and economic resilience.

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The United Kingdom's poor productivity performance since the financial crisis has raised alarm, particularly at a time of heightened uncertainty and changing demographics. However, we find that advanced economies like the United Kingdom have the potential for at least 2 percent productivity growth a year over the next ten years if policy makers and companies provide supportive action. In particular, we believe a focus on improving workforce skills, accelerating digital adoption, and promoting investment and exports is key and, indeed, in some areas, relevant initiatives are already underway. A united and sustained commitment by business and policy makers to accelerate productivity growth is necessary to increase the odds of the United Kingdom realising its full productivity potential.

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[107] *A blueprint for addressing the global affordable housing challenge,* McKinsey Global Institute, October 2014.

[108] "Live tables on house building: New build dwellings", Department for Communities and Local Government, March 2018 (www.gov.uk/government/statistical-data-sets/live-tables-on-house-building); "UK house price index", HM Land Registry, December 2017.

[109] *The 2017 London strategic housing market assessment,* Greater London Authority, November 2017.

[110] *A blueprint for addressing the global affordable housing challenge,* McKinsey Global Institute, October 2014.

[111] Business population estimates for the UK and regions 2016, Department for Business, Energy, and Industrial Strategy, October 2016; Annual business survey importers and exporters, Office for National Statistics, Novermber 2017.

[112] *From ostrich to magpie: Increasing business take-up of proven ideas and technologies,* Confederation of British Industry, November 2017.

[113] David Greenaway and Richard Kneller, "Firm heterogeneity, exporting and foreign direct investment", *Economic Journal,* February 2007, Volume 117, Issue 517, pp. F134–61.

[114] *From ostrich to magpie: Increasing business take-up of proven ideas and technologies,* Confederation of British Industry, November 2017.

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